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The Pan-Pacific Entomologist

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NATURAL ENEMIES AND INSECT SPECIATION[1]

RICHARD L. DOUTT
University of California, Berkeley

In this last month of 1959, one hundred years after the publication of *The Origin of Species*, it is fitting that this Society give some acknowledgment to the Darwin Centennial. Biologists all over the world have paused to recognize this important anniversary, to consider the impact of the theory of evolution on the thinking and culture of mankind, and to pay tribute to the man whose name has become almost synonymous with the theory which he proposed. However, it should be mentioned parenthetically that while we think of Darwin when evolution is mentioned, Darwin apparently never used the term evolution, which in its modern sense is due to Herbert Spencer (Ford, 1956).

During the past eleven months of the Darwin Centennial many scientific groups, far more elegant and famous than ours, have scheduled commemorative lectures, symposia, and appropriate exhibits. These have all been properly dignified, impressive, and praiseworthy. While few of us have been actual participants in these events, we do, nevertheless, identify ourselves with the spirit of the occasion and from it tend to derive some vicarious satisfaction. However, I think there is a much better way to commemorate Darwin's contribution. I think that each biologist, each one of us who is a student of living organisms, should take time to view from our own particular vantage point the theory of evolution and the factors that influence speciation.

It is true that our own vantage point may not offer a very superior view; there may not be much to be seen from it, or, if it does command a spectacular view, we may suffer from some intellectual myopia so that we are unable to take advantage of it. But, however handicapped we may be, I think the honesty of the effort makes it worthwhile and that it would please Charles Darwin. He was not always sure of his own position, but was frequently puzzled and confused by what he observed. It is this fact which has given me the courage to speak to you on a subject

[1] Presidential address before the annual meeting of the Pacific Coast Entomological Society at the California Academy of Sciences, San Francisco, December 12, 1959.

in which I have few qualifications. It is this fact which makes me willing to risk the charge of being presumptous in talking to you about insect speciation when I really am not conversant with the subject. I merely wish to tell you what I see from my vantage point as a worker in biological control and accordingly one who is interested in population dynamics and the role of parasites and predators.

We must start from firmly established principles, and I do not intend to depart very far from them. The great truths in biology are always immediately before us; they are not cryptic and obscure phenomena that only a few are privileged to see. For example, Darwin's Galapagos finches were seen by people before Darwin went ashore from the Beagle, and the influence of these birds even on Darwin was apparently delayed and retrospective, for it was ten years before he made any significant comment on them (Lack, 1947). I am certain that Darwin's finches have their counterparts in many phenomena that we entomologists probably see but do not recognize yet as being significant. Now I am not suggesting that I have found some new significance in rearranging some frequently observed phenomena in insect populations. Instead, I am inviting you to join me in viewing these phenomena from a novel and perhaps slightly unconventional aspect, and I further ask you to consider them in the light of the twentieth century notions about insect speciation.

The equilibrium position of a species and the balance of nature

One good starting point is the basic fact that there is a balance of nature, which means simply that barring any major changes in any given environment the resident insect species over a period of time maintain a fairly constant quantitative relationship to one another. (Smith, 1935). In this situation no single species continually increases or decreases in relation to the others. For example, consider for a moment the insect species that exist outside this hall in Golden Gate Park. If we had taken annual surveys of these insects for the past 25 years we would have found that year after year some species were always fairly abundant, others less so, and finally some species were so rare that we would have considered them to be collectors' items. We would have found this to be true because each of the species has an equilibrium

position which it maintains in relation to the other species in its environment. Of course at the same time each species fluctuates both positively and negatively from this equilibrium position because of the changing seasons, or its reproductive cycle, or to any one of many other causes, but these are short term departures only. The species population always tends to return to its normal level of abundance. This reflects the general truth which was known to Darwin and his predecessors, that, on the average, only one progeny per parent can survive, otherwise the species would increase to infinity or decrease to extinction. This, then, is the static aspect of populations; it is the seeming paradox of stability in the midst of constant change. It can be compared to sea level which furnishes us a zero basis for altitude and one of the standard conditions in the most precise of physical sciences, and yet the sea is never level but is always in motion by waves or tides.

There are entomologists who see only the dynamic aspects of populations and not these static characteristics. They are so impressed by the fluctuations of insect populations that they are inclined to deny the existence of any equilibrium position in a species. To them its existence is contrary to facts and a denial of organic evolution. My contention, on the contrary, is that this equilibrium position does indeed exist; that it is just as universal a phenomenon among insect species as sea level is among the oceans of the world. Furthermore, I believe that the tendency of a species to keep this balance is absolutely essential to the maintenance of the species because it prevents the disastrous over-exploitation of the limited requisities in the environment. I endorse the view of my colleague, Dr. C. B. Huffaker, who believes that the measure of success of a species is the relative stability of its ecological position and that any adaptation which gives increased security of ecological position will tend to be perpetuated. In other words, natural selection is involved in the maintenance of balance in populations, and this has survival value. This is, of course, difficult to prove, for as Dr. Huffaker points out, these balanced relations, as such, do not fossilize (Huffaker, in press).

By adhering to our biologists' store of well established and basic facts perhaps we can find among them persuasive evidence to support this hypothesis. For one thing, it is evident that the equilibrium position of each species is determined by the regu-

latory factors in the environment. What do we mean by regulatory factors? These are mortality agents, usually biotic, which operate in a density dependent manner. That is, as the population grows above its equilibrium position the probability of survival of any individual member of that population becomes increasingly less. In our empirical work in biological control we have demonstrated repeatedly that these regulatory factors acting on insect populations may commonly be entomophagous organisms such as predators, parasitoids, and pathogens. These natural enemies frequently regulate the abundance of the host species in any given habitat, and their action prevents wildly fluctuating host densities that could lead to the exhaustion of all the requisites of food and space in the environment and through this, absolute depletion to the ultimate extinction of the species. Instead we find that through their regulatory action the natural enemies maintain the host populations in a stable sort of existence in the environment. They are very often responsible for the balance of nature as we see it among the species of insects.

It might appear at first glance that this tendency to evolve toward a stable system would cause variability to be at a minimum and to lead to fewer and fewer species. Actually the reverse is true. For example, the results achieved over the years in biological control projects sometimes appear to be a product of latitude, for the chances of quick and effective control by importing natural enemies seem to improve the closer we approach the tropics. This merely reflects the fact that the biotic mortality factors of the environment are comparatively much more effective in tropical than in temperate latitudes. At the same time, the numbers of species are far greater in the tropics. Coupled with this great complexity in the tropical biota is the fact that the populations tend to be very stable. It is only as we go toward the higher latitudes that we find the wildly fluctuating populations. It seems evident that where there is intense inter-specific competition the course of evolution is toward greater diversity of species and greater stability of this increasingly diverse and complex system. It is my suggestion that natural enemies are very often protagonists in this evolutionary drama.

What I am suggesting is that in many insect species it is an advantage to them to have effective natural enemies. By effective

natural enemies I mean those which are quickly responsive to changes in host density and increase the intensity of their action as the population increases. Probably most of us are not accustomed to thinking that mortality factors which are increasingly severe on a growing population can actually be beneficial to the survival of that species. The notion nevertheless appears to be true that an efficient entomophagous organism or high degree of pathogenicity in a parasite or pathogen may indeed work to aid the survival of the insect host or prey species.

The predators and parasitoids that we use in biological control are fatal to their hosts, and yet there is a widely published hypothesis, which indicates an equally wide acceptance, that an organism which kills its host is, comparatively speaking, a newcomer to the ranks of parasitism. The hypothesis is that a parasite which does not tend to kill its host is a more completely adapted type which reflects a host-parasite relationship of long standing. I am not competent to judge the validity of this theory when applied to the conventional types of parasites, but it is completely erroneous when one applies it to insect parasitoids, the parasitic Hymenoptera and Diptera. With these groups I am convinced that there is a preponderance of evidence to the contrary. The morphological and physiological adaptations exhibited by endo-parasites for their life within the host individual are far from being primitive. The psychological selection of hosts by female parasitic wasps and their general searching behavior and ovipositional responses do not fit the ordinary criteria that define primitive characteristics. These facts, I think, give very strong support to the belief that insect species tend to evolve toward stable balanced relationships and are aided in this by very effective natural enemies, which are themselves well adapted species, although fatal in their action on their respective hosts or prey.

THE FRAGMENTATION OF HOST POPULATIONS BY NATURAL ENEMIES

Although still largely based on theoretical grounds, there is a belief that a very efficient parasite or predator, particularly one that tends to be host-specific, tends to break a host population up into small isolated units. These small and separated colonies are often exterminated by the natural enemy, but in the meantime there have been a few escapees or emigrants that have started

new colonies of the host. We see evidence of such a colonial distribution in many of the sessile hosts such as diaspine scales. These small and somewhat isolated populations have been termed "demes" by some geneticists and it is rather generally agreed that the division of a species into a number of partly or temporarily isolated populations of various sizes gives the conditions most likely to result in rapid evolution (Sheppard, 1956). Of course, the demes are not completely isolated, but selection, with the deme as its unit, takes the form of more rapid growth of populations of the better adapted ones and their more extensive dispersion into territories of the less adapted with consequent grading up, or even replacement of the latter (Wright, 1956).

Quite probably there are a number of factors which lead to this colonial type of distribution in insects, but I am suggesting that natural enemies can play a very important role. Whenever extrinsic factors cause an interruption or retardation in gene flow between portions of a species, then these subdivisions of the species tend to drift apart genetically (Mayr, 1948). If then a very efficient parasite can fragment the populations of its host, it is precluding absolute randomness of mating and is creating a condition in which greater variability of the host species will be possible.

Natural enemies and the phenotypic expression of insect species

While the most important role of natural enemies of insect species is in maintaining balance by regulating the equilibrium position of the given species, it has long been evident to biologists that natural enemies may play a very important part in determining which phenotypes in a species survive. In other words, without natural enemies many of our insect species might look very different. This view is, of course, based on the phenomenon of mimicry and protective coloration that we so often observe in insects.

For example let us consider a butterfly which may in the adult stage mimic a species that is distasteful to birds. We generally consider the outstanding function of such mimetic resemblance to be protection, and yet in the population dynamics of Lepidoptera we believe that the predation on the adult stage is of minor importance, whereas by contrast the attack by natural enemies on the lepidopteran eggs, larvae, and pupae is very intense.

Certainly there are abundant data to show the important part played by parasites in destroying eggs, larvae, and pupae. Furthermore, general field observations show that caterpillars are heavily attacked by predators such as birds and wasps. Yet at the same time, adult butterflies are seldom seen to be attacked by birds. So it follows that protection from attack in the adult stage can be of little, if any, importance to a species of butterfly. Therefore, if a perfect mimetic pattern appeared suddenly in a non-mimetic species, giving complete immunity from attack, it would not increase the success of the species, which would be just as successful without the mimetic pattern. At first glance this would appear to render natural selection of the mimetic pattern impossible, but actually this is not so (Nicholson, 1927).

Imagine a hypothetical situation where a perfect mimetic pattern offering complete immunity from attack appears suddenly in adults of a non-mimetic species which is subject to attack by birds capable of discriminating between the two color patterns. All the possessors of the mimetic pattern would survive to lay eggs, while a proportion of the non-mimetic adults would be destroyed by birds. Therefore the proportion of the mimetic to the non-mimetic individuals would be greater when the insects laid their eggs than it was when the adults emerged. The parasites of the developmental stages of this generation would operate to regulate the equilibrium position at the same level it was previously, but in their attack they would not operate selectively and would therefore destroy, on the average, an equal proportion of the mimetic and non-mimetic stocks. Consequently, the proportion of the mimetic to non-mimetic individuals surviving to the adult stage would theoretically be the same as that proportion which existed in the egg stage. Again the birds would act selectively against the non-mimetic adults, but the parasites would in turn act without selective action on the succeeding generation of eggs, larvae and pupae. The selective action on the adults, although perhaps very slight, would nevertheless be cumulative generation after generation until finally the mimetic form would completely replace the non-mimetics. The result would be not an increase in the numbers of the species but a species composed of phenotypes of very different appearance from the original stock.

This theory would apply to cryptic coloration equally well,

and it is in these species which have built up complicated patterns suitable for concealment on lichened tree trunks, rocks, and posts that we see the phenomenon of industrial melanism. It has been reported that of the 780 species of Macrolepidoptera which occur in the British Isles, about 70 are in the process of replacing their populations with dark or black individuals in the vicinity of soot-laden industrial areas (Kettlewell, 1956).

It is of extreme interest that such a change in gene frequency in one species will alter the amount of predation on other species in the same habitat. Accordingly industrial melanism is suggested as being an auto-catalytic process by Sheppard (1956) who also points out that the evolution of mimicry will lead to mimicry in other species with the same mode of life and living in the same area. Thus parallel evolution in mimicry tends to be produced in insects living in the same area and with similar ecologies. Consequently, it is a noteworthy but not surprising fact that where mimicry is found usually a large number of species are involved, while in other places mimicry is rare or absent.

For a long time the idea has been prevalent in biological control circles that in general vertebrate predators do not regulate the population density of any given insect species. It has been thought that birds are not quickly responsive to changes in numbers of any one insect species and are therefore not density dependent in their action. However, there are data on a few bird species, at least, which show that birds can be very important. Brower (1958) has generalized that the behavior of birds which eat phytophagous insects is such that the probability of discovery of a food item of a particular shape, color-pattern, and size is increased if the one previously found is of similar appearance and is palatable. The birds thus form a "searching image" or a "visual image" of the prey. This kind of behavior could easily lead to density-dependent predation in nature.

Experiments were conducted by de Ruiter (1952) in which twig-like geometrid caterpillars and the twigs they specifically resembled were scattered on the floor of an aviary. Individual jays were then admitted and characteristically began to hop about looking for food but in each case ignored both the twigs and the motionless caterpillars. However, after birds finally found and ate a larva then both twigs and larvae were pecked at, which

resulted in nearly all the larvae being eaten. Tinbergen (1957) discussed these experiments and said that when caterpillars outnumbered twigs, the birds went on hunting for caterpillars, but if they picked up more twigs than caterpillars, they gave up searching. From this it can be seen that the time interval between successes can not be too long if the bird is to continue searching, and in nature this interval would bear a direct relationship to how well the prey was spread out.

Brower (1958) believes that this phenomenon of persistent and successful searching after the bird has found the first prey plays a role in the food plant specialization of phytophagous insects. Brower suggests that in a situation where two closely related, pro-cryptic species are feeding together on the same plants slight genetic differences in the two species would result in them being cryptic to a slightly different extent on any one food plant species. Therefore the selection pressure by birds concentrating on the common prey image would favor those individuals of each species which were on mutually exclusive plants, and in this way the common food plant diet originally shared by all would come to be divided among them. Brower suggests that the reason that food plant specialization is so prevalent is probably because the selective advantage of being on separate plants is greater than that conferred by the initial stages of a divergence in appearance which would ultimately be different enough to be overlooked by the birds.

So far I have stressed the positive role of natural enemies in being responsible for the phenotypic expression of a species population, but there are cases where just the opposite is true and the phenotypic expression is due to the absence of biotic pressure. In this connection one can consider some of the flightless endemic species in Hawaii. As Zimmerman (1948) points out "The flightless insects of Hawaii are the descendents of cripples which survived only because in these insular environments biotic and environmental pressures are reduced to a minimum, and conditions have been favorable for their survival. They are 'hopeful monsters' arisen under circumstances in which there is hope."

"Some of these flightless species which were successful under primitive Hawaiian conditions have recently succumbed to new

biotic pressure brought about by the introduction of predators which are foreign to the Hawaiian biotal balance. Some of us have searched intensively under the very trees where Dr. Perkins procured a series of the flightless fly *Emperoptera mirabilis* Grimshaw but have never been able to find a single example of the species. It appears that this remarkable fly is now extinct—at least in the type locality—because it was unable to withstand the new pressure created by the invasion of its environment by immigrant predaceous ants." (Zimmerman, 1948.) Therefore it appears from these observations that non-adaptive radiation can take place relatively easily where there is an absence of predators or where the predator pressure is low.

Natural enemies and insect behavior

Not only may the phenotypic expression of morphological characters in a species be influenced by natural enemies, but certainly the behaviouristic characters of the species may also be the end result of the pressure of natural enemies. All entomologists are aware of the behavior of certain insects when startled, such as beetles immediately dropping from plants, insects taking flight, or perhaps feigning death.

The power of flight in insects may originally have evolved because it gave a great advantage to the insects in escaping predators, and it has been suggested that this in turn led to the development in other animals of the ability to fly. It is apparently a system of measures and counter-measures, for, while bats through echosounding locate flying insects, there are moths which have the ability to detect the ultrasonic emanations from the bats and characteristically respond by immediately ceasing flight.

Many insects, particularly in the Orthoptera, locate mates by the sound made by one of the sexes. It would seem that this might also notify vertebrates of the insect's location, but actually the sound is of such frequency that vertebrates have difficulty in locating the source. This is due to a basic difference in the manner of hearing. Each sound wave has two basic properties, one the displacement of the particles or molecules of the medium and the other the change of pressure with which this is associated. Vertebrate ears perceive pressure changes while the hearing organs of insects register particle displacement. It was pointed out by Pumphrey (1940) that since any sound involves particle displace-

ment, and particle displacement involves direction, grasshoppers can locate sounds of all types equally efficiently as long as they are within the audible range. The situation is quite different in vertebrates.

Marler (1959) reminds us of the common experience that many Orthopterans are difficult to track down by their songs. "As has already been pointed out, the 'displacement' hearing organs of insects locate sound sources in a different way from vertebrate ears, and the efficiency is unaffected by the frequency of the sound, as long as it is audible. Insects therefore are freer than vertebrates in their choice of frequency. It is interesting to note that most of them, nevertheless, lie between about 6 and 14 kilocycles per second (Busnel, 1953). In the absence of breaks to serve as time clues, this is probably a quite difficult frequency range for those birds which prey on grasshoppers to locate. One may speculate on the possibility that some insect songs are adapted so that they are both easy for insects to track down, but difficult for vertebrates. It is noteworthy, too, that crickets, with songs which are often broken and lower-pitched, around 2 to 4 kilocycles per second and therefore easier to locate, are largely crepuscular and nocturnal. Because of this, and their cryptic and often subterranean habits, they may be less exposed to predators than some other species."

INSECTS AS PLANT PARASITES

Although the title of this address indicates that emphasis is being placed on the role of natural enemies in insect speciation, I think it is profitable to digress for a moment and consider the role of insects as parasites of plants. As natural enemies of plants, the insects may well have played a very important part in determining at least the quantitative balance that we find among our plant species. As you are aware some of the most spectacular results in biological control have been in the control of weed pests by imported phytophagous insects. In California, for example, Klamath weed has been cleared from hundreds of thousands of acres of range land by the imported chrysomelid beetles, and the plant now exists as a roadside inhabitant or a plant that grows on the marginal areas of clearings. Couple with this demonstration the result of the destructive scale insects on the junipers in

Bermuda, and it is evident that insects can play a very important role in determining the quantitative composition of the flora.

Speciation in entomophagous forms

The whole subject of speciation in the entomophagous forms themselves is far too large to take up in detail in an address such as this. It is, however, one of great interest, and it is possible that a few isolating mechanisms exist among the parasitic groups that are not encountered in other insect species. I like to think of an internal parasite as living in a host that is sort of a physiological island. Thorpe (1945) reports that there is considerable presumptive evidence of the isolating effect of host conditioning in parasitic insects. He believes that the conditioned response will give momentum to and set the direction for the selective processes tending to bring about genotypic isolation. Thorpe concludes that it would seem best to regard geographical and topographical and ecological isolation as three different scales of spatial isolation. In fact it has been said by Allee, *et al.* (1949) that living organisms, as hosts to parasites, form one of the three major habitats on earth, comparable to the aquatic and terrestrial habitats in which the hosts themselves dwell. Therefore, with each host as a kind of physiological island, it is not surprising that speciation has apparently occurred frequently among the parasitoids. It is not difficult to see how extrinsic factors associated with the host might set up isolating mechanisms in parasite populations attacking it. If these were sufficient to interrupt gene flow between portions of the parasitoid species and lasted for any substantial period of time, then perhaps a new species would evolve.

There is one contribution which a study of parasitoids can make to the general subject of insect speciation and that is the disclosure of races or biological species among host insects through the differential behavior of the parasite complex. There have been a number of examples where a single morphological host species has been proved to consist actually of several distinct forms because the parasites of one form were unable to develop in the other. On the other side of the coin one finds cases where a single host may actually have several morphologically indistinguishable but biologically very different parasites attacking it. These facts arise because of the necessity in biological control of studying in detail the biological and behaviouristic characters of the host and

parasite respectively. To me the discovery of these biological entities within a well established morphological species is no criticism at all of conventional taxonomic procedures. Instead I view it as the next logical step, another dimension to insect taxonomy. This is a refinement that can be accomplished only after the basic morphological taxonomic foundation has been laid. This is, then, the expected progress and evolution in insect taxonomy toward a degree of sophistication in systematics that we now only dimly see, and it is my suggestion that insect parasites can assist us in reaching this goal.

SUMMARY

The relative stability of an insect species in its ecological position is due to regulatory factors which are often predators, parasites, or pathogens. Through the action of such density dependent agents, the evolutionary tendency is to develop increasingly complex but stable biota. The phenotypic expression of morphological characters as well as the development of certain behavior patterns in insects is often due to the selective pressure of natural enemies. The speciation of insect parasitoids is discussed in relation to modern systematics.

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TENTH PACIFIC SCIENCE CONGRESS

The Tenth Pacific Science Congress of the Pacific Science Association will be held at the University of Hawaii, Honolulu, from 21 August to 6 September, 1961, sponsored by the National Academy of Sciences, Washington, D.C., and Bernice P. Bishop Museum, with the cooperation of the University of Hawaii. Scientific sessions will be held from 21 August to 2 September, with a post-sessional field trip through 6 September.—H. J. COOLIDGE, *Secretary-General*, 10th Pacific Science Congress, Bishop Museum, Honolulu 17, Hawaii.

PRESENT STATUS OF THE TRIBE MAYETINI IN THE UNITED STATES—PART II CALIFORNIA

(Coleoptera: Pselaphidae)

ROBERT O. SCHUSTER[1], GORDON A. MARSH[2], AND ORLANDO PARK[3]

The species of *Mayetia* occurring in California are distinct from other species in the United States in that the fourth segment of the maxillary palpus is devoid of sensory developments with the exception of the cone and specialized setae (fig. 2).

Seven species are now known to occur in California. Most of these were collected during 1957 and 1958. Considering the number of species found in a relatively short period of time in a small area of California, an estimate of 25 species of *Mayetia* inhabiting the State would be conservative.

Mayetia mendocinoensis Schuster, Marsh and Park. new species

(Figs. 1–5, 9, 10)

Male.—Head 0.11 mm. long × 0.12 mm. wide; pronotum 0.13 mm. × 0.11 mm.; elytra 0.12 mm. × 0.13 mm.; total length 1.11 mm. Elongate depressed; pale testaceous; impunctate; body pubescence monaxial, primarily straight, suberect. *Head* lacking eyes; about 54 setae on dorsal surface; tempora sharply rounded to neck; two small vertexal foveae behind middle, not perforate, being about twice as deep as the depth of the integument and separated by slightly less than the distance between fovea and lateral margin; feeble sulci extend forward from each vertexal fovea; two small tubercles near the antennal acetabulae and two near the base of the head; frontal margin sinuate between moderate antennal acetabulae; clypeus short, transverse; labrum tridentate on each side of excavate middle (fig. 3); mandibles arcuate, left crossing dorsal to right; inner ramus of right mandible with symmetrical "M"-shaped tooth; basal part of "M" of tooth on left ramus reduced (fig. 5); ventral surface of head flat with small centrally located gular fovea; tentorial connection to vertexal foveae complete; two macrosetae occur posterior to gular fovea; mentum with two large integumental projections anterior to a pair of setae (fig. 4); a circular mark and two setae occur on head capsule posterior to mentum (fig. 4); maxillary palpus of four segments with one macroseta on segment III; segment I minute; II pyriform, distal anterior edge flattened; III globose; IV ovoid with a minute, straight palpal cone and two thin hyaline setae midway on outer margin (fig. 2); antenna of 11 segments, slightly verticillate; segment I twice as long as II, narrower basally; III and IV half as long and nearly three-quarters as wide as II; V noticeably wider than IV; VI scarcely narrower than V; VII longer than VI and wide as II; VIII similar to V; IX through XI form strong club with X and XI connate; IX transverse; X

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cup-shaped with four macrosetae; XI shorter than X, somewhat spongeous with seven long, lamellate setae spaced equidistally around base (fig. 1). *Thorax* with pronotum subelliptical, longer than wide; about 80 setae dorsally; definite longitudinal glabrous area weakly reticulate; lacking foveae or sulci; apterous; elytra lacking basal and subhumeral foveae; disc simple; definite foveae lacking although faint sulci parallel the suture; humeral angles rounded; lateral margins weakly expanded posterior to rounded apical angles; apices truncate; about 60 setae dorsally. Prosternum rather long, integument smooth before coxae, reticulate laterally; mesosternum simple; metacoxae contiguous, mesocoxae contiguous, the coxal cavities slightly separated; meso- and metathoracic internal structures as illustrated (fig. 9); pro- and mesotrochanters simple, metatrochanter spined; each tibia with one macroseta midway on anterior surface; a short comb of setae dorsally and a long comb ventrally near apex; apex of each tibia bearing two more or less distinct spines; tarsi of two segments ending in a single strong claw. *Abdomen* with six visible tergites, I through V similar in shape; V and VI not separated by the hexagonally marked membrane occurring between I through IV, reticulations of this membrane become more rectangular proximal to segments; segments II through V with foveae at each basolateral angle, foveae transversely connected by weak, pubescent sulci; sixth rounded distally; six visible sternites; I with wide coxal lines; II through V similar, each with foveae and sulci as in the tergites; VI with a large eccentric notch; the apices of a paired segment are external, sclerotized and terminal; a "doughnut"-shaped spiracle occurs on the first, fifth and sixth tergites. Sixth sternite is 0.067 mm. from the front of the segment medially to a line across the distal margins of the notch; notch 0.017 mm. deep. Aedeagus with a flattened, arcuate apex, of 0.135 mm. long × 0.076 mm. wide (fig. 10).

Female.—As described for the male with the following exceptions: Sixth sternite terminal, symmetrically sinuate apically; a sinuate line due either to a thickening or an inward development of the exoskeleton of the sixth sternite is visible within the terminal segment; metatrochanters not spined.

The *holotype male*, MENDOCINO, MENDOCINO COUNTY, CALIFORNIA, April 17, 1954, is deposited in the California Academy of Sciences, paratypes in the California Academy of Sciences, California Insect Survey, University of California at Davis, U.S. National Museum, and in the collections of the authors.

The specimens representing this species have all been collected in Mendocino County, California, by J. R. Helfer unless otherwise specified. Caspar, 2♀ March 7, 1954; 1♂, 12♀ July 14, 1957; 6♂, 5♀ August 4, 1957 (J. R. Helfer, G. A. Marsh). Little River, 2♀ May 3, 1955. Mendocino, 3♂, 4♀ April 17, 1954; 3♂, 1♀ March 16, 1955; 5♂, 8♀ June 18, 1957; 5♂, 10♀ July 1, 1957; 67♂, 57♀ July 6, 1957 (J. R. Helfer, R. O. Schuster); 2♂, 2♀

July 16, 1957; 2♂ July 21, 1957; 6♂, 5♀ July 24, 1957; 15♂, 5♀ August 4, 1957 (J. R. Helfer, G. A. Marsh); 2♂, 3♀ September 9, 1957; 7♂, 13♀ December 2, 1957; 19♂, 13♀ December 14, 1957.

The males of this species may be recognized by the shape of the aedeagus which is usually distinct in cleared specimens. The majority of the females examined showed a definite sinuate marking within the last abdominal segment. Since the abdomen is capable of considerable movement and measurement of the segments is difficult, no emphasis has been placed on their ratios.

The numbers of setae were counted by focusing on the dorsum at high-dry magnification and counting the setae moderately in focus. The numbers of setae are approximately the same for the other species examined from California and across the United States. The thin, hyaline setae of the antennal club are proportionately wider than those of the next species but this can be appreciated only by comparison.

The means and standard deviations of the measurements for 30 males and 30 females are given below. The head length was measured across the front of the antennal tubercles to a line across the back of the tempora. The elytral length was taken from the posterior point of the scutellum to a line across the apices. Other measurements are the maximum possible in a longitudinal or transverse direction. Total length was the distance from the front of the antennal tubercles to the end of the abdomen without considering expansion or contraction inherent in the mount. Males. Head 0.119 ± 0.004 mm. long $\times$ 0.130 ± 0.005 mm. wide; pronotum $0.133 \pm 0.003 \times 0.123 \pm 0.006$; elytra $0.119 \pm 0.005 \times 0.140 \pm 0.009$; total length 1.05 ± 0.08. Females. Head 0.120 ± 0.003 mm. long $\times$ 0.129 ± 0.004 mm. wide; pronotum $0.135 \pm 0.004 \times 0.122 \pm 0.005$; elytra $0.120 \pm 0.005 \times 0.135 \pm 0.008$; sixth tergite $0.118 \pm 0.005 \times 0.113 \pm 0.004$; sixth sternite $0.091 \pm 0.004 \times 0.130 \pm 0.005$; total length 1.12 ± 0.07.

Specimens of *M. mendocinoensis* have been taken in numbers from the top few inches of soil of undisturbed podzol profiles, probably of the Caspar series. They are commonly found in the first few inches of mineral soil of the A2 horizon and are infrequently recovered from the overlying mat of organic debris. Within the distribution of the soil series, there seems

to be no correlation between the occurrence of a particular plant species and the occurrence of *Mayetia*. *Mayetia mendocinoensis* has been taken from soil with pH readings as low at 4.1, but the largest numbers have been recovered from soils of about pH 5.5.

Mayetia walkeri Schuster, Marsh and Park, new species

(Figs. 6–8, 11)

Male.—Head 0.16 mm. long × 0.16 mm. wide; pronotum 0.17 mm. × 0.14 mm.; elytra 0.17 mm. × 0.17 mm.; total length 1.21 mm. Substantially as described for *M. mendocinoensis*. The vertexal foveae are mutually closer than the distance from fovea to lateral margin; sixth sternite is 0.079 mm. long, the notch 0.022 mm.; aedeagus has a sclerotized "median lobe," visible even within the abdomen, 0.141 mm. long × 0.077 mm. wide (fig. 11).

Female.—As described for the male with the following exceptions: Sixth sternite evenly sinuate apically and much wider than long; a straight, transverse line visible within the last abdominal segment; metatrochanter not spined.

Holotype male collected 6.4 MILES SOUTH OF KLAMATH, DEL NORTE COUNTY, CALIFORNIA from redwood litter and soil by N. A. Walker on September 20, 1955, is deposited in the California Academy of Sciences, a paratype male, same data, in the collection of Orlando Park, and one female, same data, in the collection of R. O. Schuster.

The males are easily separated from those of the preceding species by the genital structure. This difference is apparent in cleared specimens and dissection is unnecessary. The transverse line within the last abdominal segment of the female seems to divide an internal structure into basal and apical parts and easily distinguishes this species from any of the others examined. When more specimens become available for study, ratios of the length to width of the sixth tergite and sternite may be found to differ sufficiently to assist in the discrimination of this species.

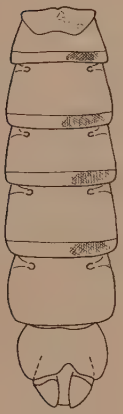
Specimens of this species have been recovered from Mendocino, Mendocino County, California. While considered conspecific they are not included in the type series. The main departure from the Del Norte County specimens is size, the specimens from Mendocino County being approximately the same as *M. mendocinoensis*. Additional series from intervening localities should be obtained to substantiate the conspecific relationship of specimens from Mendocino and Del Norte Counties.

1 mendocinoensis

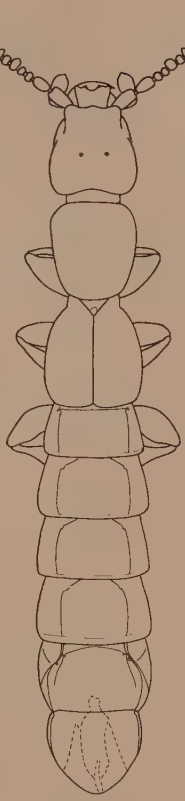
2 mendocinoensis

3 mendocinoensis

4 mendocinoensis



6 walkeri



7 walkeri

5 mendocinoensis

8 walkeri

9 mendocinoensis

EXPLANATION OF FIGURES

Fig. 1, Antennal club. Fig. 2, Maxillary palpus. Fig. 3, Labrum. Fig. 4, Mentum and front margin of head capsule. Fig. 5, Mandibles. Fig. 6, Ventral aspect of male abdomen. Fig. 7, Dorsal aspect of entire male. Fig. 8, Detail of areolate membrane. Fig. 9, Meso- and metathoracic structures, internal aspect.

Mayetia raneyi Schuster, Marsh and Park, new species
(Fig. 12)

Male.—Head 0.12 mm. long × 0.14 mm. wide; pronotum 0.13 mm. × 0.13 mm.; elytra 0.13 mm. long; total length 1.24 mm. As described for *M. mendocinoensis*. Sixth sternite is 0.059 mm. long, the notch 0.017 mm.: aedeagus cuniform, terminated apically by a membrane in which a sclerotized piece lies at right angles to the basal portion, 0.101 mm. long × 0.042 mm. wide (fig. 12).

Female.—Also very similar to that of *M. mendocinoensis*. The terminal abdominal segment is of similar shape but a subrectangular marking is usually visible in the basal half.

The *holotype male*, 10 male and 10 female paratypes were collected NINE MILES SOUTH OF MONTICELLO, NAPA COUNTY, CALIFORNIA on January 22, 1958 from 0 to 20 cm. in sand from under oak by Frank Raney and R. O. Schuster. Additional paratypes were collected as follows: Two males, eight females from the same locality on December 13, 1957 by Leslie M. Smith and R. O. Schuster; one male 10 miles south of Monticello from soil on a grassy slope on December 13, 1957 by Leslie M. Smith and R. O. Schuster; one male and one female taken from sand beneath *Umbellularia californica* nine miles south of Monticello on January 19, 1958 by R. O. Schuster; 20 males and 37 females, Napa Valley Ranch, Napa County, California on April 12, 1958 by Leslie M. Smith from soil under oaks. The holotype male and paratypes of both sexes are deposited in the California Academy of Sciences, paratypes in the California Insect Survey, U.S. National Museum and in the collections of the authors.

Both sexes of this species can be separated from the others by the described secondary sexual characters.

Mr. Frank Raney has been of assistance not only in the collection of this species but also in determining soil types and plant species for many of the collection sites.

Mayetia scobina Schuster, Marsh and Park, new species
(Fig. 13)

Male.—Head 0.11 mm. long × 0.11 mm. wide; pronotum 0.13 mm. × 0.11 mm.; elytra 0.12 mm. long; total length 1.07 mm. As described for *M. mendocinoensis* except for the secondary sexual characters. Sixth sternite is 0.059 mm. long, the notch 0.014 mm.; aedeagus with a scaly area at median one-third, 0.135 mm. long (fig. 13); metatrochanteral spine is relatively broader, being of triangular shape.

Female.—Ultimate segment of abdomen with interior opposed "comma"-shaped markings.

The *holotype male* and four female paratypes were collected FOUR MILES WEST OF NEWCASTLE, PLACER COUNTY, CALIFORNIA on March 12, 1958 from soil under *Quercus wislizenii* by Leslie M. Smith and R. O. Schuster. Additional paratypes include five males and 14 females taken from the same locality on March 21, 1958 from soil under *Q. wislizenii* and soil under grass by W. H. Lange, Leslie M. Smith and R. O. Schuster, and nine males and 18 females also from the same locality taken on April 15, 1958 by Leslie M. Smith and R. O. Schuster.

The holotype male is deposited in the California Academy of Sciences, paratypes in the California Academy of Sciences, California Insect Survey, U.S. National Museum, and the collections of the authors.

The males of this species are easily recognized by the peculiar shape of the aedeagus. The females were associated with the males by their occurrence in loci quite separate from the microhabitats occupied by a second species found in the same general area. They are distinguished by the two "comma"-shaped markings in the terminal segment of the abdomen. A series of short, transverse lines may or may not be evident anterior to these markings.

Mayetia langei Schuster, Marsh and Park, new species
(Fig. 14)

Male.—Head 0.12 mm. long × 0.13 mm. wide; pronotum 0.14 mm. × 0.12 mm.; elytra 0.13 mm. long; total length 1.03 mm. Essentially as described for *M. mendocinoensis*. Sixth tergite is 0.063 mm. long, the notch 0.014 mm.; aedeagus 0.135 mm. long (fig. 14).

Female.—Lacking identifying markings within the distal abdominal segment.

The *holotype male*, nine male and eight female paratypes were collected FOUR MILES WEST OF NEWCASTLE, PLACER COUNTY, CALIFORNIA on March 21, 1958 by W. H. Lange, Leslie M. Smith, and R. O. Schuster. Additional paratypes include one male collected five miles west, and four females four miles west of Newcastle on March 12, 1958 by Leslie M. Smith and R. O. Schuster. Most of these specimens were recovered from Aiken sandy loam of a pH range from 5.8 to 7.2. All but three of the specimens were taken under the crowns of *Quercus wislizenii*. The holotype male and paratypes are deposited in the California Academy of Sciences, additional paratypes in the California Insect Survey, and in the collections of the authors.

The males of this species are distinctive on the basis of the genitalia. The females, associated with the males because of their co-existence in small sized soil samples, seem to be inseparable from the females of the following species.

Mayetia fistula Schuster, Marsh and Park, new species

(Figs. 15, 16)

Male.—Head 0.11 mm. long × 0.12 mm. wide; pronotum 0.13 mm. × 0.12 mm.; elytra 0.12 mm. long; total length 1.03 mm. Essentially as *M. mendocinoensis*. Sixth tergite 0.067 mm. long, the notch 0.010 mm.; aedeagus 0.142 mm. long (fig. 15).

Female.—Not associated.

This species is represented by the *holotype male* and two male paratypes collected NEAR NASHVILLE, EL DORADO COUNTY, CALIFORNIA on April 25, 1958 by Leslie M. Smith and R. O. Schuster. These specimens were recovered from a clay loam, pH 6.8. The type is deposited in the California Academy of Sciences, the paratypes in the collection of R. O. Schuster.

What appears to be a single, highly variable species has been recovered from localities in El Dorado and Amador Counties. The aedeagi vary from a simple tube-like structure (fig. 16) to the form selected for the type in which the distal portion is gradually expanded forming a distinct barb on one side (fig. 15). Regardless of the degree of development of this barb, the apex remains comparatively blunt, and the width, on either side of the basal constriction, is subequal. These two features have been considered in separating *M. fistula* from the following species, the aedeagi of which might otherwise be considered within the range of variation of *M. fistula*. The variation observed in the aedeagi of the series presently considered as *M. fistula* occurs in three steps and may eventually be interpreted as representing closely related species.

Mayetia pravitas Schuster, Marsh and Park, new species

(Fig. 17)

Male.—Head 0.12 mm. long × 0.13 mm. wide; pronotum 0.13 mm. × 0.12 mm.; elytra 0.13 mm. long; total length 1.18 mm. Except for the following differences as in *M. mendocinoensis:* Sixth tergite is 0.063 mm. long, the notch 0.016 mm.; aedeagus 0.110 mm. long × 0.034 mm. wide (fig. 17).

Female.—Lacking definite marking within the ultimate abdominal segment.

The *holotype male*, five male and seven female paratypes were collected NEAR NASHVILLE, EL DORADO COUNTY, CALIFORNIA in the Consumnes River drainage on March 5, 1958 by Leslie

M. Smith and R. O. Schuster. The soil was taken from a slope on which a mixture of buckeye, bay and oak was growing. Five additional males and seven females were collected at the

10 mendocinoensis

11 walkeri

12 raneyi

13 scobina

14 langei

15 fistula

16 fistula ?

17 pravitas

EXPLANATION OF FIGURES

Figs. 10–17, Aedeagi, figs. 15, 16, represent suspected range of variation exhibited in the aedeagi of *M. fistula.*

same locality on April 25, 1958 from a clay loam with a pH of 6.8 by Leslie M. Smith and R. O. Schuster.

The holotype male and paratypes are deposited in the California Academy of Sciences, paratypes in the California Insect Survey, U.S. National Museum, and in the collections of the authors.

Although very close of the preceding species, the male aedeagus differs in being more arcuate, the distal end is acute, and the structure is considerably expanded after the basal constriction.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE: NOTICE OF PROPOSED USE OF PLENARY POWERS IN CERTAIN CASES (A.[N.S.]43)

In accordance with a decision of the 13th International Congress of Zoology, 1948, public notice is hereby given of the possible use by the International Commission on Zoological Nomenclature of its plenary powers in connection with the following cases, full details of which will be found in *Bulletin of Zoological Nomenclature*, Vol. 17, parts 3/5, published on 15 December, 1959:

(1) Designation of a type-species for the nominal genus *Bolitochara* Mannerheim, 1831 (Class Insecta, Order Coleoptera). Z.N.(S.)243;

(2) Designation of type-species for the nominal genera *Ischnopoda* Stephens, 1835, and *Tachyusa* Erichson, 1837 (Class Insecta, Order Coleoptera). Z.N.(S.)244;

(3) Suppression of the generic name *Southernia* Filipjev, 1927 (Class Nematoda). Z.N.(S.)940.

Any zoologist who wishes to comment on any of the above cases should do so in writing, and in duplicate, as soon as possible, and in any case before 15 May, 1960. Each comment should bear the reference number of the case in question. Comments received early enough will be published in the *Bulletin of Zoological Nomenclature*. Those received too late for publication will, if received before 15 May, 1960, be brought to the attention of the Commission at the time of commencement of voting.

All communications on the above subject should be addressed as follows: The Assistant Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W. 7, England.—W. E. CHINA, *Assistant Secretary, International Commission on Zoological Nomenclature.*

OBSERVATIONS ON THE NESTING BEHAVIOR OF ASTATA OCCIDENTALIS CRESSON IN CENTRAL CALIFORNIA

(Hymenoptera: Sphecidae)

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University of California, Berkeley

Recently Howard E. Evans (1957) has published biological observations on several species of the genus *Astata* together with a comparison of the behavioral patterns of the group. Subsequently we have had the opportunity of observing a relatively large colony of *A. occidentalis* Cresson in Alameda County, California. Since Evans' work included a rather thorough report on a colony of this same species at Versailles, Indiana, a comparison of the nesting habits of the populations from the two areas and some remarks on variation is of value. Evans' paper gives additional data on the nesting habits of the genus and a review of the literature.

The active colony of *A. occidentalis* Cresson was first descovered September 17, 1958, near the southern end of San Francisco Bay about two miles southwest of Warm Springs, Alameda County. Observations were made on September 20 and during the afternoons of September 23 and October 1, 1958. Weather conditions were generally clear and warm, although September 23 was somewhat windy and cooler. The nesting site was located along the bank of a slough in the mud-flat region marginal to the bay where the soil generally is a dense, moist alkaline clay with a high organic content. Vegetation in the area consists mostly of low-growing plants, primarily pickleweed (*Salicornia ambigua* Michx.), and fat-hen (*Atriplex hastata* L.). Interspersed throughout the habitat are areas of bare soil which are utilized extensively for nesting by other aculeate Hymenoptera (*Anoplius, Ageniella, Motes, Sphex, Chlorion, Nomadopsis,* etc.). The *Astata* burrows were located in an area about twelve by three meters and contained an estimated forty active female wasps. However, the twenty-nine burrows under observation were concentrated in a small portion of the site in a zone about one by three meters. In this particular area the soil consists of a 2–3 cm. layer of loose loam at the surface, and a relatively uniform understory of moist clay and is in part covered by boards, other debris and sparse growths of *Salicornia.* Most of the wasps had selected spots for burrow construction on flat ground, just above the crest of the slough bank, however, some burrow entrances were in evidence on higher areas of the south-

facing slope and entered the ground nearly horizontally. The burrows were found in the open, near, or under the pickleweed and seemed to be randomly located with respect to the plant cover and micro-topography of the site. The Warm Springs population often had burrow entrances within a few centimeters of each other. In contrast, Evans found the Indiana population in the hardpacked clay of a baseball diamond which was completely devoid of vegetation, and, perhaps due to the nature of the site, the burrows there were located no closer to one another than half a meter.

At Warm Springs, males were observed in numbers in and around the nesting site. During the warmer part of the day individuals were commonly perched on terminals of the *Salicornia* or on other protruding objects from which they occasionally darted out in short flights over the nesting area, usually returning to the same perch in a few seconds. Although Evans did not observe males of *A. occidentalis*, possibly due to the late stage of the nesting season, he reported similar flights by the males of *A. unicolor* Say, but in the latter species the perches were located some distance from the burrows. It is presumed that these flights are associated with the mating behavior, but copulation has not been observed in either species. On the basis of his observations of *A. unicolor*, Evans concluded that the females must fly into the area occupied by the males for mating. However at the *A. occidentalis* site the males were in close proximity to the females engaged in nesting. As was reported for *A. unicolor*, these flights occurred without any apparent stimulus, and active females in the area were never approached by the males during the course of our observations. It seems likely that females copulate only once, shortly after they first emerge.

The only digging activity observed was that being carried out by females with established burrows, and probably this was associated with cell construction. The process of removal and dispersal of soil was similar to that reported by Evans. In the Warm Springs colony the burrows were in general shorter and had fewer cells than in the Indiana population. In our excavations we found the burrows ranging in length from 11.0 cm. to 14.5 cm. and terminating about 9–10 cm. below the surface, whereas Evans reported that the burrows may be as much as 18 cm. long and 12 cm. deep. He also stated that a completed burrow may have up to 14 provi-

sioned cells, but our excavations showed only three to six cells associated with any one burrow, which presumably indicates that the provisioning was in an early stage.

The prey of *A. occidentalis* Cress. consists almost entirely of adult Pentatomidae (Hemiptera), and they are stored at the bottom of the tunnel before the preparation of each cell. Cell construction apparently is not initiated by the female wasp until enough bugs are accumulated to fully provision it. The elliptical cells are smooth-walled and vary somewhat in size, averaging about 7 by 16 mm. (8 by 15 mm. in Evans' study). They are constructed singly or often in linear series up to four cells in length as short side burrows to the open tunnel. When the cells were in series, we found them to be separated by filled portions 6–11 mm. thick as compared to thin portions (1–3 mm. thick) in the Indiana study on the species. In addition, we found a slightly greater range in depth of the location of the cells (6–15 cm. as opposed to 6–12 cm. reported by Evans).

The provisioning behavior of the females in the Alameda County population was essentially similar to that observed in the previous study on the species. During the course of our observations the females did not carry out as pronounced a pattern of circling around the burrow entrance on leaving as that described by Evans. This pattern, presumably one of area recognition, was quite irregular and ranged from direct departure to running up nearby vegetation or circling a small area once or twice. It seems possible that the vegetation in the Warm Springs site was of some significance in reducing the area recognition patterns in that it supplied nearby landmarks. Provisioning at the Warm Springs site was carried out slowly. The earliest that females were seen with prey was about 11:00 a.m. (Pacific Daylight Time). In the three hour period from 11:00 a.m. to 2:00 p.m., three bugs was the maximum number to have been brought in by any one female. Most of the active females had stored only two stinkbugs during this time. The stortest interval between two successful provisioning flights by a female was 13 minutes, but the average time required for a hunting trip was a little over an hour. Our limited data did not indicate any correlation between the previous experience in provisioning and the time length of trips as has been shown for other Sphecidae (e.g. *Cerceris;* Linsley & MacSwain, 1956).

The prey taken from cells and female wasps consisted of 255 adult and two nymphal pentatomids representing six species in the following numbers:

Adults:

Holcostethus limbolarius (Stål)	164
Thyanta brevis Van Duzee	77
Thyanta pallidovirens pallidovirens Stål	7
Perillus bioculatus (Fabricius)	4
Thyanta punctiventris Van Duzee	3

Nymphs:

Trichopepla ?aurora Van Duzee	1
Thyanta pallidovirens pallidovirens Stål	1

All the previous prey records for *A. occidentalis* have been adult Pentatomidae, and this use of adults has been employed as a biological criterion for the species since other species of *Astata* prey on immature Hemiptera. The finding of the two nymphs indicates that this criterion is not an exclusive characteristic, and possibly it may depend in part upon the availability of prey. The two nymphs were found in cells of separate burrows which in each case had many adult bugs stored. The stage of wasp larvae in other cells indicated that the two cells containing the nymphs were relatively recently provisioned.

As found in the Indiana population, individual wasps usually preyed on only one or a very few species of stinkbugs. One female had collected 24 pentatomids, all individuals of *Thyanta brevis*, a second had stored 24 *Holcostethus limbolarius* and 22 *T. brevis*. However, one cell was unearthed which contained four different prey species (one *P. limbolarius*, three *T. brevis*, one *T. punctiventris*, one *T. p. pallidovirens*). The source of the prey is unknown. It has been assumed in many solitary wasp studies that the female repeatedly returns to the same habitat where prey is available, and this might account for the relative uniformity in bug species selected by *A. occidentalis* females.

Fully provisioned cells were found to contain from four to nine bugs, averaging 6.3, a significantly higher number than that reported for the species in Indiana. It is possible that the average of 3.8 bugs per cell in the latter population is at least in part due to a larger average size of the pentatomids since the predominant species of prey at Warm Springs have smaller individuals than those recovered by Evans. The prey was usually placed in the cells

in the head-in, venter-down position reported by Evans for both *A. occidentalis* and *A. unicolor*, but a certain amount of variation was observed. This was especially noted in the final few bugs of a cell, and possibly it was due to the smaller size of the prey in the Alameda County colony causing them to not fit uniformly in the oval cells. The placement of the egg is also identical with that recorded for *A. occidentalis* and *A. unicolor*.

The transport of prey is much the same as observed in the Indiana population. Some variation was noted in the manner in which the wasp supported the prey while walking near the burrow. The smaller bugs were grasped in the wasp's mandibles by the base of the beak, while in transport of larger prey she provided additional support with the fore and mid legs, although these were used for walking at the same time. On arriving at the site with prey, the female alighted on the ground or on the *Salicornia*, usually about 10–20 cm. from the burrow, and as Evans reported for the species, the approach to the burrow entrance which followed was usually quite circuitous.

None of the bugs in our study recovered from the effects of the sting. A great deal of variation in these effects was nonetheless noted. Some in freshly provisioned cells had already died, while others were kept alive in the laboratory and responded to touch for many days. One individual showed reaction for 39 days.

In contrast to the colony studied by Evans which was heavily parasitized by miltogrammine flies, only a small percentage of the cells exposed by our excavations had been destroyed by natural enemies. Although adult specimens of three species of miltogrammine sarcophagids (*Senotainia litoralis* Allen, *Metopia leucocephala* Rossi, *Metopia* sp. near *inermis* Allen) were collected in the nesting site, none were seen to follow prey-laden females, nor were maggots of these flies encountered in any cells. Of over 50 cells seen, two had been parasitized by a larger fly, one had been destroyed by ants and onther by mold. Neither of the adult flies emerged from the puparia. Two hymenopterous parasites were collected in the nesting area, but no definite association could be shown for these. Several females of the tiphiid wasp, *Myrmosa bradleyi* Roberts were taken crawling about the nesting site, and one male was netted nearby. One individual was seen to enter an *Astata* burrow, and in another instance a female *Myrmosa* was recovered during the excavation of a nest tunnel. Three specimens

of a chrysidid wasp. *Hedychrum* sp. were collected flying about the burrow sites. In addition, remains of sphecid wasps of several genera were found in the webs of Black Widow Spiders, *Latrodectus mactans* (Fabr.) amongst the *Salicornia* in the nesting site, and this spider is assumed to be an occasional predator of *A. occidentalis* in this locality. Finally, remains of excess stored pentamoids were found in several instances to be utilized by an undetermined dipterous scavenger.

Acknowledgement for determinations is gratefully made to Dr. R. M. Bohart, University of California, Davis (the *Astata* and *Hedychrum*), Professor H. J. Reinhard, Texas A & M College (Sarcophagidae), Dr. Herbert Ruckes, American Museum of Natural History, New York (Pentatomidae), Marius S. Wasbauer, University of California, Berkeley (the *Myrmosa*), and to Dr. J. W. MacSwain, University of California, Berkeley, for reading the manuscript and offering helpful suggestions.

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1956. Some observations on the nesting habits and prey of Cerceris californica Cresson (Hymenoptera, Sphecidae). Ann. Ent. Soc. Amer. 49(1):71–84.

A NEW ENTOMOLOGICAL JOURNAL

Volume 1, number 1 of "Pacific Insects," dated July 15, 1959, has been distributed. It is a large, excellently printed journal, and should be a welcome and distinguished addition to the list of entomological periodicals. Four issues annually, totaling about 400 pages, are planned.

An explanatory paragraph states, "This journal is the organ of the program 'Zoogeography and evolution of Pacific insects' sponsored by the Entomology Department, Bishop Museum, Honolulu. It is devoted primarily to monographs or zoogeographical papers on insects and other terrestrial arthropods from the Pacific area, including eastern Asia, Australia, and Antarctica." Dr. J. Linsley Gressitt of the Bishop Museum is editor.

The subscription rate is $5.00 per volume, payable to the business manager of the Journal, Dr. C. M. Yoshimoto, Bishop Museum, Honolulu. Remittances in Yen or Stirling may be made to the business agent in Japan, Dr. K. Yasumatsu, Kyushu University, Fukuoka, Japan.

SEVERAL NEW SPECIES OF NORTH AMERICAN ORTHOPTERA

H. F. STROHECKER
University of Miami

The specimens on which the following descriptions are based have come to me in the collections of the California Insect Survey or from Mr. Jacques Helfer of Mendocino, California. Included is the description of a grasshopper which I collected many years ago in northwestern Florida.

Mr. J. A. G. Rehn of the Academy of Natural Sciences in Philadelphia, Dr. W. L. Brown of the Museum of Comparative Zoology, and Dr. Ashley Gurney of the U.S. National Museum have lent specimens of several little known species of Acrididae useful in the study. Dr. Gurney has also supplied drawings of the aedeagus of the unique type of *Melanoplus sonomaensis* Caudell.

GRYLLACRIDIDAE

Daihiniodes valgum Strohecker, new species

(Fig. 1)

This insect is referred to *Daihiniodes* largely on the basis of its tarsomeres. three in the front tarsus, four in the middle and hind tarsi, but it seems to combine the features of several rhaphidophorine genera as defined by Hubbell in 1936. The second and third articles of the hind tarsus are heart-shaped and carinate beneath as in *Rhachocnemis*, rather than distinctly spinose, while the spurs of the hind tibiae are elongate and crowded distad as in *Ammobaenetes*. The membranous area on the lower surface of the last joint of the maxillary palp extends two-thirds the length of the joint.

Head as in *D. hastiferum* (Rehn), fastigium flat and perpendicular. *Legs:* front tibia with four stout spurs on ventro-caudal margin and four slender spurs on ventro-cephalic margin (excluding terminal calcars). Front femur with a slender genicular spur on cephalic face. Middle femur with genicular spur on both faces. Middle tibia with four spines on each dorsal edge and two spurs on each ventral edge. Hind femur with many denticles on dorsal surface, its ventro-cephalic carina with 21 small spines distributed along its entire length. Hind tibia strongly bowed, each dorsal edge with eight spurs (including the dorsally directed calcar) and a number of denticles. The distal six spurs elongate, inner series longer and crowded distad forming a "sand-basket." *Subgenital plate* membranous, prolonged into two tapering lobes. The color of the insect is a rather uniform pale brown. Length of body 20 mm.: of pronotum 5.1 mm.; of front femur 6.9 mm.; of hind femur 16 mm.

Holotype male, PALM SPRINGS, RIVERSIDE COUNTY, CALIFORNIA.

June 1, 1949 (L. M. Smith), deposited at the California Academy of Sciences, San Francisco.

ACRIDIDAE

Trimerotropis helferi Strohecker, new species

(Fig. 2)

Male.—Form short and robust for the genus, in general proportions resembling *Microtes*. Femora, tibiae, coxae and adjacent areas of sterna and pleura clothed with long, white hairs, much as in *T. (olim Circotettix) maculata* (Scudder) but less dense. *Color* light gray and tan, thickly maculate and punctate with black, maculae of tegmina hardly aggregated into cross-bands. Wing disc hyaline or very feebly tinged with yellow, the black band narrow and interrupted in axillary region, reaching hind margin but little extended along it. Costal spur short, reaching less than halfway to base of wing. *Legs:* Front and middle femora and tibiae annulate with black. Hind femur with fuscous mottling in basal half of external face, and a fairly definite dark band at apical third, upper and lower edges of the external face and upper and lower flanges minutely, seriately maculate with black. Lower sulcus pale with a narrow, dark band before apex. Hind tibiae brownish yellow, darker apically, knees dusky. *Head* large, in frontal view wider across cheeks than across eyes (8:7), frontal costa deeply sulcate, its carinae continued with only a slight undulation at foveolae as the margins of the fastigium, which is rather deeply impressed and as wide as dorsal diameter of eye. Median carina of pronotum subcristate on prozona, weakly notched by first sulcus, principal sulcus deep. Lateral carinae feebly indicated on anterior lobe of prozona, definite but rounded on metazona. Hind margin of pronotum forming an angle slightly greater than 90°. Lateral lobes with lower hind angle broadly rounded. Length of body 19 mm.; of pronotum 3.7 mm.; of tegmen 18 mm.; of hind femur 10.3 mm.

Female.—Larger and stouter than the male. Coloration similar but tegminal maculae aggregated into a diffuse basal area and a cross-band at mid-length. Fastigium shallower and broader than in male. Length of body 28 mm.; of pronotum 5.3 mm.; of tegmen 24 mm.; of hind femur 14 mm.

Holotype male and allotype female. CLEONE, MENDOCINO COUNTY, CALIFORNIA, August 6, 1958 (J. R. Helfer), deposited in the U.S. National Museum (No. 64567). Paratypes: 47 males and 48 females with the same data as the holotype, and five males and two females collected by Helfer at Cleone on August 8, 1958.

Additional specimens at hand were taken by Helfer near Petrolia, Humboldt County on July 17, 1958, at Arcata and Mad R. Mts., July 1919 by E. C. Van Dyke, at Eureka, June 24, 1924 by J. M. Aldrich, June 11, 1935 by E. O. Essig. All these localities are in Humboldt County. A series of four males

and one female taken by E. G. Linsley, July 4, 1956, at Grover City, San Luis Obispo County, are remarkably short and stout with the tegmina extending only to the tips of the femora. The body length of these males is 14–14.5 mm. and the tegmina measure only 12.5–13.5 mm. Corresponding measurements for the female are 21 and 18 mm.

I have considered the possibility that the name *Trimerotropis pilosa* McNeill might be applicable to this species, but that name was probably based on small specimens of *T. pallidipennis* (Burmeister). In general appearance *helferi* resembles a small specimen of *maculata* but its closest relationship is probably with *T. arenacea* Rehn, from which it differs in stouter form, broader head, color of hind tibia, and hairiness.

Dr. Gurney, on learning of my study of this species, generously sent to me the entire series submitted to the National Museum by Mr. Helfer as well as the biological notes of the collector. Apparently *T. helferi* occupies a habitat niche similar to that of *T. maritima* (Harris) and *T. acta* Rehn and Hebard on the Atlantic coast, *i.e.*, it is an occupant of the first line of dunes. Plants with which the insect was associated are *Convolvulus soldanella* L., *Franseria chamissonis* Less., and *Artemisia pycnocephala* DC. Determinations of these were made by Dr. S. F. Blake of the Plant Industry Station at Beltsville, and communicated to me by Dr. Gurney.

Melanoplus fricki Strohecker, new species

(Fig. 3)

Resembles *M. hesperus* Hebard in size and coloration. Tegmina apically rounded. Cercus similar to that of *hesperus* but wider at base. Suranale with a transverse ridge on each side at mid-length. The most distinctive features are found in the structure of the phallus. Length of body 15.2 mm.; of pronotum 3.5 mm.; of hind femur 9 mm.

Holotype male, KING'S MOUNTAIN, SAN MATEO COUNTY, CALIFORNIA, September 28, 1941 (Kenneth Frick), deposited in the California Academy of Sciences. Allotype female with data as for holotype. It is doubtful that features adequate for differentiation can be found in the females of this group of *Melanoplus*. Paratypes: two males and two females with the same data as the holo- and allotype.

Melanoplus muricolor Strohecker, new species

(Fig. 4)

So similar to *M. nanus* Scudder that a general description is not necessary.

Tegmina three-quarters as long as pronotum, narrowly separated, apex evenly rounded. Arms of furcula attenuate, divergent. Lateral margins of suranale reflexed, forming a rather deep trough, median ridges laterally tuberculate at about mid-length of plate. Cercus similar to that of *nanus* but slenderer. Length of body 14 mm.; of pronotum 3.2 mm.; of hind femur 8.5 mm.

Holotype male, SANTA CLARA COUNTY, CALIFORNIA, September 11, 1941 (Kenneth Frick), deposited in the California Academy of Sciences. Allotype female with data as for holotype. This specimen, associated with the male, is designated the allotype, but I am unable to say in what ways it differs from the female of some other species of the *nanus* group .

In the figure of the phallus, the right side is represented as it appears in the dried state.

Melanoplus gurneyi Strohecker, new species
(Fig. 5)

A small grasshopper of the *puer* (Scudder) (s.s.) group. In Hubbell's key (1932. Miscell. Pub. 23, Univ. Mich. Museum Zoology, p. 17) it runs out to *apalachicolae* Hubbell, which it closely resembles, although smaller than the average size of that species, and with the cerci symmetrically styliform rather than dorsally excised. The edges of the suranale are not undulate over the cercal bases and the arms of the furcula are brief, rounded lobes, shorter than the tenth tergite. The phallic structure is distinctive. Length of body 12.8 mm.; of pronotum 2.6 mm.; of hind femur 8 mm.

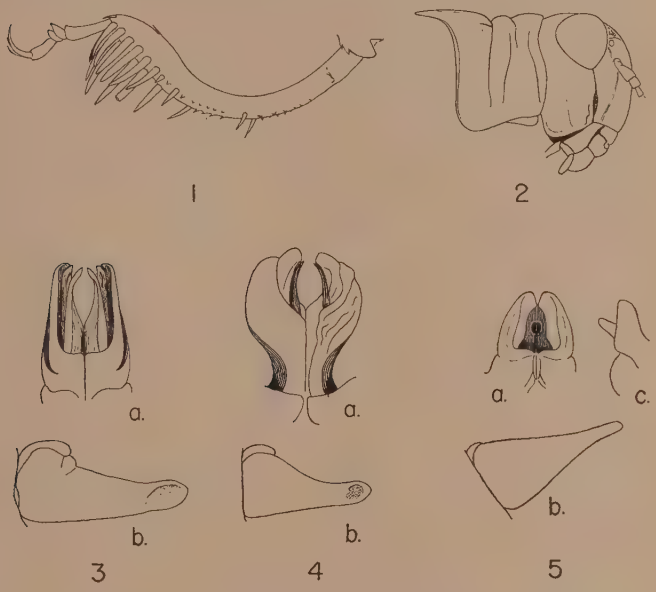
Holotype male, BEACON BEACH (now Tyndall Field), BAY COUNTY, FLORIDA, August 6, 1940 (author's collection).

Allotype female with same data as the holotype and resembling the female of *apalachicolae* to the point of identity. Paratypes: 20 males and 16 females taken with the types. The habitat of the species is a xeric sand area with *Ceratiola* the most abundant plant, this associated with dwarf oak and basil-weed. The clumps of basil-weed were occupied by *Hesperotettix gemmicula* Hebard.

Seven males collected at Inlet Beach differ from the topotypes in the greater development of the aedeagal valves, which are strongly protuberant when viewed from the side. The cerci are also proportionately shorter in the Inlet Beach specimens, but these structures show variation in length in both series.

The drawings of the phallic structure were made from potash-

glyceral preparations except the right side of figure 4a, which is drawn from the dried state.



EXPLANATION OF FIGURES

Fig. 1, *Daihiniodes valgum* Strohecker, left hind tibia of male. Fig. 2, *Trimerotropis helferi* Strohecker, head and pronotum of male. Fig. 3, *Melanoplus fricki* Strohecker, male; a. caudal view of phallus; b. left cercus. Fig. 4, *Melanoplus muricolor* Strohecker, male; a. caudal view of phallus; b. left cercus. Fig. 5, *Melanoplus gurneyi* Strohecker, male; a caudal view of phallus; b. left cercus; c. lateral view of phallus of Inlet Beach male.

ERRATA

Abbott, C. H., 1959. Pan-Pac. Ent. 35:84; line 32, read Calipatria instead of Carpinteria. The butterflies were moving out of Sonora in a west-northwest direction in the Imperial Valley.

Schuster, R. O., G. A. Marsh and O. Park, 1959. Pan-Pac. Ent. 35:117; line 11 read Dr. John R. Bowman instead of Dr. Robert Bowman.

A FRAGMENTARY OBSERVATION ON THE MATING BEHAVIOR OF TIMULLA

(Hymenoptera: Mutillidae)

Apparently relatively little is known of the mating behavior of the mutillid wasps of the genus *Timulla*. The only published data known to me relate to an observation by Fattig (1936).[1] Near Atlanta, Georgia, late in July, 1935, he observed large numbers of males of *T. briaxus* Blake flying under a tree above a tumbling mass of males about one and one-half inches in diameter, which surrounded a pair in copulation. Fattig picked up the mass and when the loose males quickly flew away he preserved the mating pair and was unable to note further activity.

On July 27, 1959, near an artificial water hole (dirt-banked tank for the use of livestock) nine miles north of Apache, Cochise County, Arizona, a wasp was seen in flight carrying an object and was mistaken for a predator with its prey. When captured, they proved to be a copulating pair of *Timulla (Timulla) oajaca* (Blake).[2] The male, being more than twice the size of the female, held the latter beneath the body by means of the legs and the curved abdomen and affixed genitalia. The two remained in copulation when placed in cyanide and the genital clasp was not released even after death.

The mating pair was flying under a broken sky with scattered clouds at 12:15 p.m. When first observed they were about 30 inches above the ground, flying in a straight line toward the southwest. They were captured when they alighted on a plant of Russian Thistle about 18 inches above ground level. Mickel (1937)[3] records the capture of a mating pair of this species at Cotulla, Texas, May 11, 1906 (J. C. Crawford) and another at College Station, Texas, July 10, 1931 (H. J. Reinhard), but no details are given of the particular circumstances.

A similar observation involving a tiphiid wasp, *Myrmosa bradleyi* Roberts, at Tracy, San Joaquin County, California, was made by J. W. MacSwain on June 7, 1949. In this instance the male was carrying the female in flight, but the two did not remain in copulation after capture.—E. G. LINSLEY, *University of California, Berkeley.*

[1] Fattig, P. W., 1936. An unusual mating of velvet ants (Hymen.: Mutillidae). Ent. News, 47:51-52.
[2] Identified by W. E. Ferguson, University of California, Berkeley.
[3] Mickel, C. H., 1937. The mutillid wasps of the genus *Timulla* which occur in North America North of Mexico. Ent. Amer., 17:1-119.

A REMARKABLE INSTANCE OF SEXUAL DIMORPHISM IN A NEW SPECIES, RHOPALANDROTHRIPS NILGIRIENSIS

(Thysanoptera: Terebrantia)

T. N. ANANTHAKRISHNAN
Loyola College, Madras-31, S. India

Notable records of sexual dimorphism among terebrantian Thysanoptera from India are rare, except for such of the more common characteristics of the male, as their apterous nature, lack of ocelli, and so forth. In this connection, mention may be made of *Exothrips madrasensis* Ananthakrishnan, where joint V of the male antenna is unique in being small, distinctly concave at inner margin, convex along the outer and with a tooth-like protuberance carrying a well developed spine, at the apex of the inner margin. Further, the fore-tibia in the male is armed with a sharp tooth at apex within, a character also met with in *Perissothrips parviceps* Bagnall and *P. aureus* Ananthakrishnan. *Rhopalandrothrips* Priesner, has elongated, bacilliform antennae in the male, more especially the VI joint which is so modified, a character much as in *Sorghothrips* Priesner. The sixth antennal joint is as long as joints III and IV in *Rhopalandrothrips ricini* Shumsher, the only hitherto known species from India; in *Rhopalandrothrips consociatus* (Targioni-Tozzetti), joint VI is as long as the combined lengths of all the other joints while in *R. obscurus* Uzel, it is longer. *Rhopalandrothrips nilgiriensis* new species, is remarkable, since the VI antennal joint of the male is nearly five times as long as that of the female and much longer than the combined lengths of the other joints. It must also be stated in this context, that in *R. nilgiriensis*, apart from the differential nature of joint VI in the male, there is considerable difference in the sizes and shapes of antennal joints III-V. There is a progressive decrease in the sizes of joints III-V, the fifth being short, cup-shaped and broadly united with the sixth.

Rhopalandrothrips nilgiriensis Ananthakrishnan, new species

Macropterous female: Total body length, 1.16 mm. Body colour: Head and thorax orange yellow; abdominal segments I-VIII pale greyish yellow; apex of IX and X dark grey brown. Antennal joints uniform brown. Forewings greyish, setae brown; hindwings pale, with a longitudinal brownish streak; fringes brown. Legs, yellowish grey. Eyes black, ocelli with dark red pigment. *Head* 1.2 times broader than long, being 120μ long and 140μ wide across eyes. Vertex slightly depressed between eyes. with a distinct notch between antennal bases. Eyes prominently

pilose, about as long as cheeks. Postocular setae short, 28μ long and interoculars 32μ long. Head at base with clear transverse striae. Mouth cone 122μ long, reaching near the hind margin of prosternum. Maxillary palp 51μ long, individual joints measuring 22, 13 and 16μ long respectively. Labial palps 16μ long. Antenna nearly 2.5 times as long as head; segments 3 and 4 vase-like with slender, pointed, horseshoe-like sense cones. *Antennal joints*, length (width) in μ:—29(26); 38(26); 51(19); 54(19); 34(16); 45(19); 8(8); 16(6). *Prothorax*, 140μ long at middle, hind margin distinctly arched, surface densely setose. Anterior angles with a small spine 19μ long; hind angles with a pair of well developed spines, outer 58μ long and inner 61μ long; hind margin with two pairs of spines, the outer small and half as long as the inner, which is 35μ long. *Pterothorax*, 238μ long. Wings well developed, 910μ long, 98μ wide at base, 56μ at middle and 35μ at tip. Wing chaetotaxy: costa 26; upper vein 4 + 3 (at base) + 2 (at tip); lower vein 16 in a row. *Abdomen* broad at middle, narrowing towards apex; VIII abdominal segment with a well developed comb. The outer, middle and inner bristles of IX abdominal segment, 93, 125 and 166μ long respectively; tenth segment with outer and inner bristles 109 and 115μ long; ovipositor 238μ long.

Macropterous male: Total body length 1.008 mm. Coloration as in the female, but darker; head and thorax of a darker hue; abdomen darker grey brown; wings grey brown with an orange tinge; antenna darker brown. *Head* 112μ long, 126μ wide across cheeks; cheeks slightly serrate, with transverse striae at base. Eyes 70μ long and almost as wide. Antenna more than three times as long as head. Antennal joints III–VI totally differing in size and shape from those of the female, especially joint VI which is nearly five times as long as that in the female, profusely setose, the setae arising from distinct warts. Antennal joints, length (width) in μ: — 29(26); 38(28); 43(21); 26(19); 16(19); 211(29 at base); 5(3); 10(5). *Prothorax* 112μ long, 168μ wide at base; pterothorax 252μ long, 224μ wide across mesothorax and 196μ wide across metathorax. Wings well developed, 742μ long, 70μ wide at base, 49μ at middle and 42μ at tip. Wing chaetotaxy: costa 26; upper vein, 6 (at base) + 2 (at tip); lower vein. with 15 in a row. The outer, middle and inner bristles of IX abdominal segment and the outer and inner bristles of the X abdominal segment, 77, 64 and 102μ and 86 and 77μ long respectively. *Genitalia*, Length of hypophallic arms and the median phallus, subequal, 99μ long.

Holotype male and a female on pear leaves. May 3. 1957. POMOLOGICAL STATION. COONOOR (5500'). INDIA. Types with the author (T.N.A. 274).

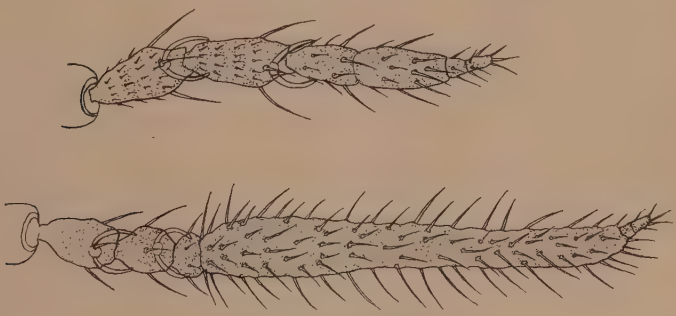
A comparison of *R. nilgiriensis* with the other species of the world. namely. *R. annulicornis* Uzel. *obscurus* Uzel. *consociatus* (Targ. Tozz.). *corni* Moulton and *ricini* Shumsher reveals that it is now possible to classify the existing species into two groups. namely, the *consociatus* group. with antennal joint VI of the

male as long as or much longer than joints I-V together, and the *annulicornis* group with joint VI shorter than joints I-V respectively. Accordingly, *R. nilgiriensis* Ananthakrishnan belongs to the *consociatus* group while *annulicornis*, *obscurus*, *corni* and *ricini* belong to the *annulicornis* group.

KEY TO SPECIES OF RHOPALANDROTHRIPS (MALES)

1. Antennal joint VI longer than combined length of joints I-V.....2
– Antennal joint VI shorter.....4
2. Joint VI as long as or slightly longer than combined length of I-V ..... *consociatus* (Targioni-Tozzetti)
– Joint VI very much longer.....3
3. Lower vein of forewing with 14 or less setae.....*obscurus* Uzel[1]
– Lower vein with more than 14 setae.....*nilgiriensis* Ananthakrishnan
4. Antenna 6-jointed, apterous.....*annulicornis* (Uzel)
– Antenna 8-jointed, macropterous.....5
5. Joints III and IV much shorter than VI.....*corni* Moulton
– Joints III and IV as long as VI.....*ricini* Shumsher

The author is particularly indebted to the Ministry of Education, Government of India, for the award of a grant for the survey of Thysanoptera of Ootacamund and Kodaikanal Hills.



EXPLANATION OF FIGURES

Rhopalandrothrips nilgiriensis Ananthakrishnan; upper, antenna of female; lower, antenna of male.

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[1] The female of *obscurus* shows definite differences from *nilgiriensis*.

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AN ADDITIONAL NOTE ON THE LIFE HISTORY OF MITOURA SPINETORUM (HEWITSON)

(Lepidoptera: Lycaenidae)

A lycaenid larva taken on May 16, 1959, at Russelman Park, Mt. Diablo, Contra Costa County, California, by W. S. Ross, was subsequently turned over to Tilden, who reared from it a normal male of *Mitoura spinetorum* (Hew.).

The larva was found on Pine Dwarfmistletoe (*Arceuthobium campylopodum* Engelm.), a previously recorded foodplant. The larva pupated on May 17, and the imago emerged June 14, 1959, after the long pupal period of twenty-eight days. The color of the larva matched the foodplant perfectly. The pupa however was very dark brown and was hidden in the branches of the foodplant and held in place by an incomplete silken girdle.

This insect is uncommon in the Mt. Diablo area. This is the first recorded rearing of the species from Contra Costa County or from the San Francisco Bay Region of California.

There appear to be but three previous references[1] to the life history habits of *Mitoura spinetorum*.—J. W. TILDEN, *San Jose State College, San Jose, California.*

[1] Comstock, J. A., & C. M. Dammers, 1938. Bull. So. Calif. Acad. Sci. 37:30-32.
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PACIFIC COAST ENTOMOLOGICAL SOCIETY

R. M. BOHART, *Vice-President* R. L. DOUTT, *President* D. P. FURMAN, *Secretary*

PROCEEDINGS

Two Hundred and Sixty-third Meeting

The two hundred and sixty-third meeting of the Pacific Coast Entomological Society was held February 28, 1959, in the Morrison Auditorium of the California Academy of Sciences, San Francisco, California. President R. L. Doutt called the meeting to order at 2.00 p.m.

The following members were present: H. Ruckes Jr., E. S. Ross, D. D. Jensen, E. O. Essig, R. M. Bohart, A. E. Michelbacher, W. H. Nutting, L. Caltagirone, E. L. Kessel, W. W. Middlekauff, P. H. Arnaud, Jr., L. M. Henry, T. S. Acker, E. P. Catts, J. A. Powell, J. R. Powers. D. Burdick, J. W. Tilden, R. Langston, D. Giuliani, K. W. Brown, C. J. Rogers, J. E. Henry, T. Seeno, R. S. Dahl, D. H. Huntzinger, A. Samuelson, C. D. MacNeill, F. J. Santana, J. G. Edwards, H. B. Leech, D. P. Furman, F. E. Skinner, R. C. Miller. Visitors registering were: Arden E. Palmer, Sheila Palmer, Aldeau Clemens, John Sanjean, Margaret E. Bohart, P. S. Messenger, Mrs. P. S. Messenger, Mrs. Richard Doutt, Walter Thomsen, Samad Vojdani, J. A. Chemsak, Mary Ann McHenry, Mrs. Jerry Powell, Jerry I. Stage, Byron N. Chaniotis, Frank Parker, Lionel A. Stange, Jeanette Rogers, William A. Freeman, Soenoto Atmosoadjono, Mrs. R. Dahl, Lynda Dahl, Mrs. Rita Huntzinger, Mr. and Mrs. S. S. Rivas, Max Barret.

The minutes of the meeting held December 13, 1958 were read and approved.

The President announced the following appointments to the committee to judge the entomological exhibits at the forthcoming state science fair: Kenneth Hagen (Chairman), Laura Henry, H. B. Leech.

Dr. Ruckes proposed the following nominees for full membership in the Society: Sheila Palmer, Paul Marsh, O. S. Bindra, K. R. Thakare. He also nominated E. Paul Catts for student membership. Hugh Leech nominated Ted Spilman for full membership. J. G. Edwards nominated for full membership: Calvin J. Rogers, John E. Henry, Fred J. Santana, and Kirby W. Brown. The nominees were elected to membership by unanimous vote.

In response to the President's call for notes and exhibits, Dr. Ruckes projected color slides of the sugar pine cone beetle, *Conophthorus lambertianae* Hopkins. He noted that the beetle spends the winter as an adult in the mined tip of a sugar pine twig. This winter there appears to be a very large population of surviving cone beetles as evidenced by the great number of mined twig tips visible on the sugar pines in the Sierras. This is the first time in the past four years that such a high population has been recorded.

Dr. J. W. Tilden exhibited a preserved pair of ixodid ticks in mating posture. The male is much smaller than the female, and is fastened with the chelicerae apparently attached to the genital opening of the female.

Mr. H. B. Leech projected slide transparencies of an adult female of *Cuterebra latifrons* Coquillett which he collected from the basement of his home.

Mr. E. P. Catts, to whose attention the living cuterebrid had been brought, stated that approximately 275 eggs were laid by the fly. In efforts to rear adults from these eggs, a total of 40 host individuals of six rodent species were infested with from one to six first instar larvae per host. Infestation was accomplished by allowing the larvae to penetrate the nares of the hosts. No apparent annoyance to the host was caused by the initial penetration. Mature larvae were obtained from the house mouse, laboratory rat and a wood rat, *Neotoma fuscipes*. Three larvae from *Neotoma* and *Rattus* pupated and emerged after 36-41 days. Two were males and one a female. Identification of the specimens was made by Dr. Curtis Sabrosky of the U. S. National Museum.

Miss Alice Gray, of the American Museum of Natural History, gave an interesting account of the decorative uses of insects. Miss Gray commented on the varied uses of insects in costume jewelry, in designs for clothing material, as models for toys and in a variety of other adaptations. Her comments were highlighted by a fascinating collection of exhibits.

Mr. H. B. Leech of the California Academy of Sciences, described his recent winter collecting trip to the Cape region of Baja California, Mexico. The following account is given verbatim.

"Mr. Alan Leviton, herpetologist of the California Academy of Sciences, and I left San Francisco on December 3, 1958, in an almost new ¾-ton International 'Travelall', equipped with 4-wheel drive, a power winch, and 8-ply tires. Stopping at the San Diego Museum of Natural History we got advice on road conditions from Dr. George Lindsey and Mr. Huey—and as a result had overload springs installed the next day. At nearby La Mesa we enjoyed the hospitality of Dr. and Mrs. F. X. Williams.

"By road from Tijuana, the peninsula of Baja California is almost a thousand miles long. The first 140 miles or so, to Arroyo Seco, are paved; the next 40 have been graded but are now severely washboarded. Beyond El Rosario one enters the region of interesting endemic plants, and travels over some of the roughest roads in North America. The country is rugged, with jagged and barren-appearing mountains in view most of the time as one travels, till the Magdalena Plains are reached just before the Cape region. The road is nearly all single track, through sand, gravel, rock (where it is sometimes too narrow to allow dual tires), and dirt; it often follows arroyos and flood plains, where both the surface and placement change with every heavy rainstorm. In the Cape region travel is much easier, except after floods and between Todos Santos and Cabo San Lucas.

"Because of a time schedule, no collecting stops were made between Tijuana and La Paz, although a few things were taken at night on camp stops. At Canipole we turned southeast to Loreto, then up a wonderfully scenic canyon (mostly one-way road, with grades to 23%) where water beetles could be seen from the car as we forded streams.

"At La Paz we were joined on December 17 by Dr. Ira L. Wiggins of Stanford, leader of the expedition. Arrangements were made to rent a house for headquarters and storage of equipment. Much help and advice were received from residents, especially Mrs. Margaret Waters, Mr. Walter Heyne-

man, and Dr. and Mrs. Eduardo Ajuria. Contact was also made with Mr. and Mrs. K. Bechtel, the expedition's sponsors, and three one-day collecting trips made in their plane. On December 21 Mr. Duncan Porter, botany student of Stanford University, arrived and collected with us until the end of the year. Mr. Allyn Smith, conchologist of the California Academy of Sciences, and Dr. Reed Moran, Curator of Botany at the San Diego Natural History Museum, came by plane on January third and finally returned with us; Dr. Wiggins had to leave on January 10.

"We collected in the Cape region, around La Paz and down to and around the cape, from December 18 to January 27, when we shipped on the boat Korrigan IV, Captain Elizondo, for Guaymas, and drove home via Tucson, Arizona. Entomological collecting was generally poor, though there were many shrubs in flower. The Gulf side east of the Sierra de la Victoria, from Cabo San Lucas to east of La Paz, had a terrific rain storm with hurricane winds last September. Though it wrought extensive damage, especially at San Jose de Cabo, it also resulted in extensive plant growth, and the cattle were in better condition than for many years. Dr. Wiggins decided that we should take advantage of the unusually lush winter conditions in the low country, so we did not go into the mountains at all.

"Despite the many flowers, there were vitrually no Hymenoptera, Diptera or Heteroptera on them, and only a single beetle, a cerambycid, was taken on a flower. One common mallow-like shrub, *Melochia tomentosa* (Sterculiaceae), did attract large long-tailed skippers in numbers, and a rarer vine, *Cardiospermum halicacabum*, had butterflies, wasps and flies at the flowers; pretty green hairstreaks were so intent on *Cardiospermum* nectar that they could be picked off with tweezers, one after another. Along the road about 6.5 miles north of Todos Santos many noctuid moths could be seen at night on the nectar-producing flowers of *Agave* sp., but most were out of reach; flowers of other species of *Agave* seen were not nectiferous.

"With one exception, collecting with a beating sheet was totally unproductive, because there were virtually no insects on the trees and shrubs (many of which were too thorny to beat, anyhow). The exception was *Yucca valida*; by beating the pads of dead leaves hanging around the trunks of the living trees, I got many insects sheltering there: carabids, monommids, bruchids, chrysomelids, in the Coleoptera; silver fish, cockroaches, katydids, spiders and scorpions tumbled out, and sometimes numbers of ants and termites. *Polistes* sp. were an occupational hazard of this type of collecting, and produced a good deal of activity when their nests were unknowingly banged.

"Sweeping with a heavy net was impractical because of the rigid and/or spiny nature of nearly all the shrubbery. Butterfly collecting was good so far as numbers of species and specimens, especially skippers, was concerned; but it was nearly impossible to chase any active butterfly, except along paths or roads, because if I took my eyes off the ground to watch the insect, I was in cactus or sprawled over a rock in no time.

"Some luck was had by turning over the many cardón trunks felled by the September storm, and rock rolling was fairly good if you liked scorpions. Large coastal sand dunes at Rodriguez, some 20 miles west of La Paz, and

those of San Lucas, gave some interesting Tenebrionidae, and at the latter place cockroaches. Smaller coastal dunes southeast of La Paz promised much, for they were obviously covered with the tracks of large nocturnal tenebrionids; upon patrolling them at night with a light, I was terribly disappointed to find that these track-makers were soldier crabs.

"During January, night temperatures in the lowlands of the Cape region averaged between 50° and 60° F., yet light collecting with a Coleman lantern was very poor. A few moths usually came in, and sometimes swarms of small corixids, but often not a single beetle. Much better luck was had during the colder evenings in the northern half of the peninsula, during our trip down in early December.

"In individuals, the most common insect species was *Polistes* sp. or spp. These wasps were ubiquitous and a nuisance; they often swarmed around the car, wherever we happened to stop it, and even forced us to eat our lunch away from the desirable shade of the vehicle. They were a real hazard to butterfly collecting, because the swinging net disturbed and annoyed them. Other than for butterflies, the only really productive collecting was on the few occasions that we found suitable water.

"Irrigation streams and flood pools gave few species, though often in large numbers. But natural streams and seepages, not necessarily permanent, yielded a fine lot of aquatics, including half a dozen new species and a number of new records for the region. For instance, a good stream in Arroyo Aqua de los Pasos, about 12.5 miles east of La Paz on the road to Las Cruces, produced at least 15 species of Dytiscidae and Hydrophilidae on January 4, but on January 23 it was bone dry. A pool three feet long and a foot deep, at the end of a drying up trickle at Arroyo Saltito, near Las Cruces, contained over 30 species of Dytiscidae and Hydrophilidae, including *Hydrochus* sp., a genus not previously reported south of Hamilton Ranch, some 700 miles north."

Dr. P. S. Messenger of the University of California Experiment Station described the large, controlled environmental test chambers currently in use at the Albany station for research on insect biology. These chambers were formerly used in Hawaii and in Texas for fruit fly investigations. Their use enables the investigator to duplicate the seasonal fluctuations of a region in question at any time of the year, including diurnal variations. Dr. Messenger demonstrated use of the chambers with a series of projection slides.

The meeting was adjourned to the "Coffee Social" at 4:00 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-fourth Meeting

The two hundred and sixty-fourth meeting of the Pacific Coast Entomological Society was held April 11, 1959, in the Morrison Auditorium of the California Academy of Sciences, San Francisco, California. President R. L. Doutt called the meeting to order at 2:05 p.m.

The following members were present: D. P. Furman, T. Palmer, E. S. Ross, K. S. Hagen, R. H. Van Zwaluwenburg, D. D. Linsdale, J. A. Powell, W. E. Ferguson, L. E. Caltagirone, F. E. Skinner, J. Milstead, P. D. Hurd, Jr., D. G. Denning, D. Burdick, E. P. Catts, K. W. Brown, T. S. Acker, H. B. Leech, T. C. Lawrence, J. G. Edwards, P. H. Arnaud, Jr., C. D. MacNeill,

C. Cushner, R. L. Doutt, R. L. Langston, E. L. Kessel. Visitors registering were: A. E. Palmer, Clark Ross, W. E. Simonds, P. S. Messenger, Padre Francisco S. Pereira, A. Earl Pritchard, Ron Stecker, Wm. M. Thwaites, John P. Herron, Ronald E. Wheeler, Don R. Totten, Catherine Toschi, Robbie, Rick and Stephanie Ferguson.

The minutes of the meeting held February 28, 1959 were read and approved.

The President announced that the judging of the exhibits at the state science fair would be held on the following week-end. He also stated that the date for the annual field day of the Society had been set for May 16th at Russelman Park.

In response to the call for nominations for members to the Society, Dr. P. D. Hurd, Jr., nominated Charles W. O'Brien, a graduate student in systematics at the University of California. Dr. Hurd also proposed that William E. Simonds of the Bureau of Entomology, California Department of Agriculture, be reinstated as a regular member. Dr. Ken Hagen nominated Mr. Jim Milstead, a graduate student in the Department of Entomology at the University of California, and Dr. Allan D. Telford at the Department of Biological Control, University of California, Albany. The three candidates and the one applicant for reinstatement were unanimously elected to full membership in the Society.

In response to the President's call for notes and exhibits Don Burdick noted that at the December meeting of the Society Mr. Wasbauer and he had stated that adults of *Methocha californica* Westwood probably would not emerge until next spring. The prediction was proved erroneous with the emergence of a male on January 16, 1959. Details of cocoon spinning were discussed.

Dr. E. S. Ross exhibited a book, "Aphidoidea of the Middle East" by Bodenheimer and Swirski. The book is particularly noteworthy in view of the stress placed on the ecology and physiology of aphids.

Jerry A. Powell exhibited examples of a hepialid moth, *Hepialus sequoiolus* Behrens. Pupae and larvae were collected from galleries in stems of *Lupinus arboreus* at Pt. Reyes, Marin Co., Calif. on February 27, 1959, and one male was taken at the same time. *H. sequoiolus* has long been known to be a borer in the lower stems of this plant, the habits of the species having been first described by Williams (Ent. News, 16:285. 1905) in San Francisco. In this connection, a point of interest to note is that there are three additional species of Micro-lepidoptera which were described from the San Francisco sand dune area that have been taken from the bush lupine at Pt. Reyes during the last two years. These are the tortricids, *Argyrotaenia franciscana* (Walsingham), a leaf feeder, *Epinotia infuscana* (Walsingham) which bores in the stem tips, and lastly *Grapholitha imitativa* Heinrich, a very common moth flying amongst the lupine in April and May, the larvae of which have not as yet been discovered.

Ronald Stecker exhibited a cerambycid beetle, *Xystrocera globosa* (Olivier) collected at San Jose State College about April 1st. It apparently emerged from ash or mahogany imported from Japan or the Philippines. The

beetle is widely distributed throughout Madagascar, Egypt and the Oriental region.

Mr. Stecker also described a technique for collecting fleas from rodents without harm to the host. The animal is paced in a jar which has just been rinsed with 70 per cent ethyl alcohol. The fleas quickly jump from the host, sticking to the damp surface of the jar. The rodent is then removed, the jar rinsed with alcohol again, pouring the rinse into a collecting vial along with the fleas.

Mr. H. B. Leech showed some color slides illustrative of problems encountered in this type of photography. One slide of a living *Metriona bicolor* (Fabricius) showed no trace of the beautiful golden color of the insect, the electronic flash having done away with it, and depicting instead, the anatomical details under the iridescence.

Leopoldo Caltagirone, Entomologist of the National Entomological Station, La Cruz, Chile discussed the recent changes in the scope of entomological studies in Chile. He cited the earliest publication, to his knowledge, on the natural history of the country written by a Chilean as the "Saggio sulla storia naturale del Chili", by the Jesuit Abbe Juan Ignacio Molina, published in Italy in 1782. In the 19th century foreigners like Gay, Germain, Philippi and Reed contributed greatly to knowledge of Chilean insects. Carlos Porter, in the late 1800's and first three decades of the 20th century, influenced studies of Chilean natural history. During the same period, working in pure and applied entomology, were Manuel Jesus Rivera, Carlos Silva Figueroa, Carlos Camacho, Claude Joseph, Flaminio Ruiz, Carlos Stuardo, and others. These men and their works form the Chilean entomological tradition. At present however, entomology in Chile is not taught as an independent professional field, but merely a subject in the curricula of agronomy, veterinary and human medicine, and biology. Entomologists in Chile in the recent past have specialized either in taxonomy or economic entomology, with little stress on ecology or distribution of insects. Encouraging support has been given recently to advancement of the ecological and biogeographical aspects of the field.

Padre F. S. Pereira, C.M.F., Departamento de Zoologica, Secretaria de Agricultura, Sao Paulo, Brazil, discussed Brazilian entomological collections. The principal collections are at Rio de Janeiro and Sao Paulo. In Rio de Janeiro are the Museo Nacional, Escola Nacional de Agronomia and the Instituto Oswaldo Cruz. In Sao Paulo are the Departamento de Zoologica and the Instituto Biologico. Padre Pereira listed a number of active workers together with their fields of interest.

Mr. Frank Skinner next exhibited a series of color slides of coccinellids feeding on aphids. He also placed on demonstration an exhibit of color slides, so arranged as to be viewed simultaneously by transmitted light.

Mr. R. H. Van Zwaluwenburg, Entomologist, Hawaiian Sugar Planters' Association (retired) discussed his recent tour of European museums in connection with his work on elaterid beetles of the Pacific area. He noted that most of the types are located in European museums. He gave his impressions of the major museums of Europe with interesting sidelights on personnel and facilities encountered.

Following a brief discussion the meeting was adjourned to the "Coffee Social" at 3:15 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-fifth Meeting

The two hundred and sixty-fifth meeting of the Pacific Coast Entomological Society was held as a field day, May 16, 1959, at Russelman Park, Contra Costa County, California.

The following members registered: E. G. Linsley, J. W. MacSwain, W. W. Middlekauff, O. W. Graf, D. P. Furman, P. H. Arnaud, Jr., H. Ruckes, Jr., W. E. Ferguson, Sheila Palmer, E. S. Ross, J. W. Tilden, R. L. Langston, J. Milstead, D. M. Maddox, F. E. Skinner, J. E. Swift, K. Brown. Visitors registering were: R. W. Stark, Phyllis Middlekauff, Marguerite E. Arnaud, Mr. and Mrs. Arden Palmer, Patricia Palmer, J. W. Tilden family, R. L. Langston family, Samad Vojdani, Ray F. Smith, Stephanie Ferguson, Wilda Ross, Mustafa Ozer, Jim Milstead family, Frank Skinner family, Deane Furman family, John Swift family.

An informal field day meeting of the society was held on the slopes of Mount Diablo. Hiking, collecting, swimming and baseball were among the more strenuous activities, but the shaded park benches and tables drew their share of attention, as a place to visit with old friends and new acquaintances. —DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-sixth Meeting

The two hundred and sixty-sixth meeting of the Pacific Coast Entomological Society was held October 17, 1959, in room 113 Agriculture Hall, University of California, Berkeley, California. President R. L. Doutt called the meeting to order at 2:10 p.m.

The following members were present: R. L. Doutt, R. C. Miller, R. M. Bohart, R. L. Usinger, T. S. Acker, R. L. Langston, Y. Tanada, H. B. Leech, P. H. Arnaud, Jr., F. R. Cole, J. W. Tilden, R. F. Smith, J. R. Powers, E. E. Lindquist, D. H. Huntzinger, E. G. Linsley, K. S. Hagen, F. E. Skinner, J. E. Milstead, W. E. Ferguson, R. W. Thorp, E. P. Catts, D. P. Furman, O. S. Bindra. Visitors registering were: Margaret E. Bohart, Rodger Mitchell, Herbert C. Brodahl, David C. Brodahl, A. Earl Pritchard, Paul R. Ehrlich, Libby Smith, Soemarlan, Stamford D. Smith, Fred Watari, Bill Freeman, Barry E. Pullen, Philip S. Barker, Theodoros Buchelos, Panayotis Doxopoulos, Frank J. Radovsky, H. T. Gordon.

Dr. Ray Smith welcomed the members and guests of the Society to the meeting at the University of California.

The minutes of the meetings held April 11th and May 16, 1959 were read, corrected and approved.

The President announced the following awards made by the Society at the 1959 State Science Fair: Honorable Mention to Art Horning of the Sunset School, Carmel, California. First Place to David Brodahl of Winton School, Hayward, California. David was presented with the book, Living Insects of the World, by A. B. Klots and E. B. Klots.

The President announced that the committee to select a slate of nominees for Society officers for 1959 is composed of Kenneth Hagen, Hugh B. Leech, J. G. Edwards, Chairman.

The Auditing committee selected by the Executive Board consists of J. W. Tilden, Chairman, C. Don MacNeill, Ray Smith.

In response to the request for nominees for membership the following candidates were proposed for full membership: K. L. Mahler, John F. Lawrence, Dan Brinkman, Junji Hamai, Cornelius V. O'Connell, Jr., Michael J. Cowell and T. R. Haig. Ray F. Smith was nominated for reinstatement as a full member. The candidates were elected to full membership by unanimous vote.

Dr. Ray Smith discussed the organization of entomology as a discipline at the University of California, noting that teaching of entomology started 68 years ago on the Berkeley campus. A basic feature of the training at this campus is the development of a scholarly attitude by the student, who not only must fulfill requirements in basic courses in entomology but also in a wide variety of other fields such as botany, genetics, chemistry and zoology. While both undergraduate and graduate majors in entomology are trained, the majority of students are graduates. At present there are 77 graduate students in entomology at Berkeley.

Dr. Smith outlined briefly typical examples of current research projects under investigation by staff of the Department of Entomology and Parasitology. The California Insect Survey was inaugurated formally in 1947. The objective is a survey of the insect fauna of the state. The official publication is the Bulletin of the California Insect Survey, which was started in 1950. Other projects mentioned were "Insects in amber". Literally thousands of specimens are now on hand, many dating back to the Oligocene period. In forest entomology active research is progressing on determination of factors involved in tree selection by beetles. Four staff members are working on insect vectors of plant diseases. Two staff members are investigating the biology and ecology of wild bees, significant agents in the pollination of wild and cultivated plants.

Dr. Usinger discussed problems in biosystematics of bedbugs, pointing out that he is in a unique position, in that he has representatives of all the 50 known species and 20 genera of the world, and has most of them alive in cultures at present. Much remains to be done, however, before the systematics of the Cimicidae is clarified. On his recent collecting trip in Africa he collected a new species of *Leptocimex* in which the organ of Ribaga, previously considered a reliable generic guidepost, is very different from that of other members of the genus. At the species level in various genera he has found numerous characters which seemed valid, but upon analysis these have been found to vary indiscriminately. A detailed study of the Cimicidae of the world is the continuing object of his attention.

William W. Allen discussed control of the cyclamen mite as a research project which involved more or less routine screening of insecticides. Even so, in the final development of an effective control it was shown to be necessary to determine the persistence of residues on the fruit, as well as to determine the detrimental effects which insecticides might have on natural enemies of the mite. *Hoplia* beetles were described as pests which attack the roots of strawberries. Although strawberries are attacked in the same areas where *Hoplia* adults damage grapes, biological studies show that the

two are separate species. The *Nemocestes* weevils were discussed as another native insect which became a pest when strawberries were planted in close proximity to their native hosts.

Dr. Harold Gordon presented a talk on current developments in insecticide resistance, which is summarized below.

Since house flies became DDT-resistant about 1947, there has been an unbroken series of victories by the insects over chemical control by synthetic organic insecticides, and it now seems likely that any insect species can in time acquire resistance to any one insecticide. The insecticide industry has not been seriously worried until recently, because the development of DDT-resistant strains at first seemed to be a welcome opportunity for the introduction of competitive insecticides. However, the increasing occurrence of "positive cross-resistance" is now causing universal concern.

With DDT-resistant house flies, lindane or aldrin gave excellent control for a time, but then strains of flies arose that were resistant to lindane and aldrin and still resistant to DDT. Later use of organic phosphates gave rise to strains that were resistant to phosphates and still resistant to chlorinated insecticides. These strains are in fact "pre-adaptively" resistant to some of the new carbamate insecticides (such as Sevin or H-57) which have never been used on flies. Such extreme "posititive cross-resistance" would seem to spell the death of chemical control. This is especially depressing because even if the use of all insecticides is discontinued for several years, resistance declines but does not disappear completely, so that re-use of insecticides re-selects highly resistant strains in one or two generations.

Since it is hopeless to look for an insecticide which is "resistance-proof", toxicologists are studying ways of using two or more insecticides. One approach being examined by Dr. Hoskins at Berkeley is the detection of incipient resistance, from small changes in dosage-mortality curves that occur while effective control is still possible. The hypothesis is that shifting to another insecticide will reduce or eliminate the "positive cross-resistance" which occurs when the shift is made too late, i.e., when high resistance to the first has already appeared.

Another idea is the finding of insecticides which can be used in alternation. The theory is that resistance to one insecticide will decline as resistance to the other increases, and that the decline will be fast enough to allow successful continuous alternation of the two.

My own preference has developed in the last year, and favors the simultaneous use of two insecticides capable of giving "mutual synergism". The possible mechanism of this effect rests on the fact that high resistance to an insecticide seems to involve the development of a high concentration of a fairly specific enzyme that can destroy it. "Mutual synergism" can occur between two insecticides which are dissimilar enough so that two distinct detoxicating enzymes are required to destroy them, but similar enough so that each can protect the other from the action of its specific enzyme. Such synergism will not occur between any two insecticides. However, neither will it be an extremely rare effect, difficult to find.

Dr. Richard Bohart discussed the entomology summer field course of the University of California. This is a required course for all undergraduate

majors in entomology. It is given over a four to six week period of the summer at various localities. Most of the sessions have been held in California, but a very rewarding period was spent recently in the Chiricahua Mountains of Arizona where the American Museum of Natural History operates its Southwestern Research Station. The course provides assurance that entomology students experience a variety of field collecting, observing the activity of insects in their normal environments.

In response to the President's call for notes and exhibits, J. W. Tilden exhibited a glow worm, evidently a larviform female of some species of Lampyridae, which was taken by Bruce Tilden on the evening of August 2, 1959, at the lower end of Madera Canyon, Santa Rita Mountains, Arizona. It glowed very brightly but intermittently and would stop glowing if disturbed. It fed on slugs and angleworms, surviving until October 12, 1959.

E. P. Catts displayed an exhibit of two living Cuterebrids collected in Marin County, California. These were collected as part of a study on these myiasis producing Diptera of rodents. The specimens are unusual in that they possess pronounced red eye spots. The species is unknown.

Numerous other exhibits were placed on display by members of the staff and graduate students of the Department of Entomology and Parasitology.

The President noted that a "coffee social" and display of exhibits would follow the formal meeting. The meeting was adjourned at 4:20 p.m.—DEANE P. FURMAN, *Secretary*.

Two Hundred and Sixty-seventh Meeting

The two hundred and sixty-seventh meeting of the Pacific Coast Entomological Society was held December 12, 1959, in the Morrison Auditorium at the California Academy of Sciences, San Francisco, California, President R. L. Doutt called the meeting to order at 2:10 p.m.

The following members were present: R. L. Doutt, W. A. Doolin, J. W. Tilden, D. Giuliani, C. J. Rogers, Judy Ross, K. W. Brown, D. H. Huntzinger, J. G. Edwards, R. L. Usinger, L. A. Stange, B. N. Chaniotis, A. Menke, P. Marsh, F. E. Skinner, E. P. Catts, Laura M. Henry, J. W. MacSwain, W. D. Murray, W. A. Russell, D. D. Linsdale, T. Lawrence, P. H. Arnaud, Jr., T. Acker, D. Rentz, J. A. Powell, W. E. Ferguson, K. S. Hagen, D. P. Furman. Visitors registering were: Mrs. R. M. Bohart, Mrs. Blanca Labrador, Mr. and Mrs. Walter D. Riley, José Ramón Labrador, J. T. Doutt, Mrs. Richard Doutt, Richard J. Doutt, Mrs. Calvin J. Rogers, Ronald E. Wheeler, Stamford D. Smith, Ronald E. Hall, Jalil Abul-Hab, Fred Iltis, Soemarlan, Fred Watari, Monroe H. Pastermack, Jr., Michel M. J. Lavoipierre, Nancy C. MacSwain, John MacSwain, Gerald I. Stage, Roy R. Snelling, Paul Ehrlich, Mrs. Jerry Powell, Mrs. William E. Ferguson, P. S. Messenger.

The minutes of the meeting held October 17, 1959 were read and approved.

The following nominees were proposed for regular membership: David C. Rentz, Ronald E. Hall, Stamford D. Smith, Miss Judy Ross, Frank Parker. The candidates were elected to regular membership by unanimous vote.

Dr. R. C. Miller presented the Annual Report of the Treasurer.

Dr. J. W. Tilden, reporting for the Auditing Committee, stated that the Society books had been examined and found to be in order. The above two reports were accepted by unanimous vote and a copy of the Treasurer's Report placed on file.

J. A. Powell, reporting for the Editorial Committee, stated that the Pan-Pacific Entomologist had printed 220 pages this year in addition to indices, and some 25 manuscripts have been submitted for future issues.

H. B. Leech, Chairman of the Historical Committee, reported that our file of letters by the Coalburg, Virginia lepidopterist, W. H. Edwards, all to W. G. Wright of San Bernardino, California and apparently complete for the period 1882-1905, have been loaned to Mr. F. Martin Brown for study.

He also noted that Mr. E. R. Leach of Piedmont has presented the first section of his entomological correspondence and hopes to be able to get the late F. W. Nunenmacher's letters for the Society's historical file. Another recent acquisition is the Owen Bryant correspondence, much of it relating to specimens now in the California Academy of Sciences' collections.

President Doutt announced that Professor E. O. Essig and Mr. R. H. Van Zwaluwenburg have been reappointed to three year terms on the Publication Committee.

Reporting on the state of the Society, President Doutt noted that there are approximately 350 members, about 150 of whom receive notices of meetings. During the past year the average attendance of members at meetings has been 47.

In response to the call for notes and exhibits Paul Arnaud noted that a caterpillar of the monarch butterfly collected in the fall of 1957 at Redwood City, San Mateo Co., California produced a tachinid fly maggot which emerged during the chrysalis stage of the host. However the chrysalis later produced an apparently normal butterfly. Only two species of tachinids are known from the monarch in this area, and although the maggot died in the process of pupating, it may possibly be identified later from the preserved larva.

Paul Ehrlich reported briefly on the annual meeting of the Society for the Study of Evolution and the Darwinian Centennial Celebration held at Chicago in November. He stated that the entomological contributions were among the most outstanding presented.

Mr. Leech mentioned having visited one of our members, The Rev. Edward Guedet, at Notre Dame Hospital, San Francisco, where he has been for the past year. He is in good spirits and would enjoy visits from entomologists. His fine collection of Lepidoptera was presented to the Academy during the period 1944-1950.

In view of the present interest in collecting by means of mercury vapor lights, Mr. Leech drew attention to a prediction by the late Owen Bryant that this should be the best attractant light (1908. Science, N.S. 28 (727): 797–798).

Jerry A. Powell read a note concerning a collection of Noctuidae visiting flowers. On the evening of September 23, 1959, a number of moths were seen hovering about the flowers of glossy abelia, *Abelia grandiflora*, a common ornamental bush of the honeysuckle family, on the University of Cali-

fornia, Berkeley campus. Collections were made from a number of bushes at that time and at dusk the following day (about 7:30-8:00 p.m. P.D.T.) during typically cool, breezy evenings for the area. Seven species of noctuids were taken in the following numbers, *Pseudaletia unipuncta* (Haworth) (3), *Heliothis zea* (Boddie) (2), *H. virescens* (Fabricius) (5), *Autographa egena* (Guenee) (1), *A. biloba* (Stephens) (2), *Trichoplusia ni* (Hübner) (3), and *Mouralia tinctoides* Guenee (3). Although most of these are abundant and widespread species and are commonly encountered in other parts of California, Powell had encountered only *unipuncta* and *biloba* in Berkeley in four years' collecting at lights. In addition, *Mouralia tinctoides* is a relatively little known species in this area, apparently not having been previously recorded north of Santa Barbara, California.

William Ferguson, who attended the recent Centennial meeting of the American Entomological Society at Philadelphia, noted that this was the first society devoted to Entomology in the United States. In many respects the Society is not unlike the Pacific Coast Entomological Society today.

J. G. Edwards announced that Dr. Otto Swezey died on December 7, 1959.

Dr. Usinger moved that the Society express its condolences to Mrs. Swezey over the death of Dr. Swezey. The motion was seconded and passed by unanimous vote. The Secretary was directed to send the letter.

Dr. Edwards, reporting for the nominating committee, nominated the following members to serve as Society officers during 1960: President, J. W. Tilden; Vice President, Paul H. Arnaud, Jr.; Secretary, Frank E. Skinner; Treasurer, Robert C. Miller.

The nominees were elected to office by unanimous vote.

The Chair was turned over to incoming President J. W. Tilden, who called upon retiring President R. L. Doutt to deliver the Annual Address, titled "Natural Enemies and Insect Speciation".

The address, which will be published separately in the Pan-Pacific Entomologist, was followed by a spirited discussion, with particular interest centering around the concept that factors affecting populations are all density dependent versus the concept that certain factors are independent of density.

As a final item on the agenda J. G. Edwards projected a colorful series of slides depicting his activities in collecting alpine insects in Montana and Canada.

The meeting was adjourned to the "Coffee Social".—DEANE P. FURMAN, *Secretary*.